DOCUMENT RESUME

ED 421 656 CE 076 923

| | |
|---|---|
| TITLE | Engineering Technologies. State Competency Profile. |
| INSTITUTION | Ohio State Univ., Columbus. Center on Education and Training for Employment. |
| SPONS AGENCY | Ohio State Dept. of Education, Columbus. Div. of Vocational and Career Education.; Ohio Board of Regents, Columbus. |
| PUB DATE | 1998-05-07 |
| NOTE | 419p. |
| PUB TYPE | Guides - Classroom - Teacher (052) |
| EDRS PRICE | MF01/PC17 Plus Postage. |
| DESCRIPTORS | Associate Degrees; *Competence; Competency Based Education; Electricity; Electronics; Employment Potential; Engineering Education; *Engineering Technicians; *Engineering Technology; High Schools; *Job Skills; Teaching Guides; *Tech Prep; *Technical Occupations; Two Year Colleges; Vocational Education |
| IDENTIFIERS | *Ohio |

ABSTRACT

This document contains 397 competencies, grouped into 58 units, for tech prep programs in the engineering technologies cluster. The competencies were developed through collaboration of Ohio business, industry, and labor representatives and secondary and associate degree educators. The competencies are rated either "essential" (necessary to ensure minimal levels of employability by entry employees; must be included in all new tech prep programs) or "recommended." Competency builders are included for each competency. A matrix relates the units to five occupations within the engineering technologies occupational cluster. Some of the groups of competencies covered in the units include the following: employability skills; professionalism; teamwork; professional practices; workplace safety; project management; problem analysis; general administrative functions; economic and business principles; basic computer concepts and applications; quality assurance; technical recording and reporting; supervision; drafting technology; visualization and design for function; computer-assisted design/drafting technology; electricity; fundamentals of electronics technology; analog circuits; digital logic circuits; microcomputer electronics technology; instrumentation control technology; electro-optic technology; electronics troubleshooting and repair; electronic product servicing technology; industrial electricity; wiring methods; electronic assembly and repair; equipment maintenance; industrial manufacturing; electromechanical technology; hydraulics and pneumatics; computerized numerical control; precision machining; metal stamping dies; press technology; sheet metal fabrication; material joining technology; and welding basics. (KC)

********************************************************************************
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
********************************************************************************

ED 421 656

TECH PREP

# Engineering Technologies

# State Competency Profile

May 7, 1998
Columbus, Ohio

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☐ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY
L Daniels
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

CE076923

TECH PREP

# Engineering Technologies State Competency Profile

This document is the result of collaboration between a number of individuals and organizations. The Ohio Department of Education and the Ohio Board of Regents provided financial and staff support for the development of the document. Dr. Richard Bailey, Tech Prep Consultant, drafted key units and edited the initial document upon which the current document is based. Guidance in document development was provided by a futuring panel composed of Ohio Business, Industry and Labor Representatives. (See attached list of Futuring Panel Members.)

The current document is a result of a review by a state-wide panel of business/industry/labor representatives and secondary/associate degree educators on May 7, 1998. (The name and institutional affiliation of each panel member is provided on the following pages.) Jan Eley, Akron Area Tech Prep Consortium, Linda Fauber, Lakeland Tech Prep Consortium, Jennie Royer, Stark Tech Prep Consortium, and Julie Daugherty, Eastern Ohio Valley Tech Prep Consortium served as meeting facilitators.

As you review the document, keep in mind the following: .

***Essential Competencies***

Those competencies marked *Essential* in the State Competency Profile were determined by the statewide business/industry/labor panel to be necessary to ensure minimal levels of employability. Entry level employees should be able to perform this competency without supervision; therefore, students must be proficient in these competencies at least by the end of the Associate Degree.

*Essential* competencies must be included in all new Tech Prep programs. Tech Prep consortia with current programs in this area will be expected to phase-in essential competencies into their programs as well.

Wording of essential competencies may not be altered. The leveling may only be changed to deliver the competency earlier during the educational process. For example, the leveling of an essential competency in the State Competency Profile may be altered locally from a P or

Proficiency leveling at the end of the Associate Degree to a P or Proficiency by the end of the 12th grade. The reverse is not permissible. For example, a competency leveled P or Proficient by the end of the 12th grade in the State Competency Profile cannot be changed locally to a P or Proficiency by the end of the Associate Degree. For additional information on leveling of competencies, refer to the Leveling Code Sheet.

Competency builders are intended to help define each competency; therefore, the builders may be modified as long as that modification does not change or dilute the intent of the State Panel.

Issues which arise regarding delivery of the *essential* competencies once the program is implemented will be addressed by a State review panel of business/industry/labor and education representatives with possible revisions to the State Competency Profile at a later date. Any issues identified during the local verification meeting should be conveyed to Tech Prep Curriculum Services by the meeting facilitator.

### *Recommended Competencies*

The competencies marked *Recommended* are suggested additions to the State Competency Profile. Each of these competencies should be reviewed during a local competency profile meeting; with a joint panel of business/industry/labor and education representatives deciding whether to include each competency in the local curriculum. The decision should be based upon a consideration of local business needs, as well as priorities and time constraints of the educational process. Wording and leveling of all recommended competencies and builders may be modified.

### *Additional Units/Competencies/Builders*

Competencies and/or builders may be added to any unit in the State Competency Profile. Additional units may also be added.

### *Occupation Definitions*

Skills may be added to the occupational definitions based on the modifications made during the competency review. Because the definition is based on the skills detailed in the competency profile, only minor modifications should be necessary.

For additional information about this State Tech Prep Competency Profile contact:

Sara Mazak
Tech Prep Curriculum Services
Center on Education and Training for Employment
The Ohio State University
1900 Kenny Road
Columbus, Ohio 43210-1090
614-292-8404

# Engineering Technologies Futuring Panel
## April 14, 1998
## Columbus, Ohio

**Linda Fauber**
Panel Facilitator

**Blaine Lilly**, Assistant Professor
Department of Mechanical Engineering
The Ohio State University
Columbus, Ohio

**Keith Rosnell**, President
MBS Engineering Solutions
Cincinnati, Ohio

**Larry Tracewell**
Tracewell Systems
Westerville, Ohio

**Per Flem**
Performance Plastics
Cincinnati, Ohio

# Engineering Technologies
# State Competency Profile Meeting

## Business, Industry, Labor Panel

**Beth Adams**, Director, Special Projects, Administration
General Tool Company, Cincinnati, Ohio

**Perry Ballinger**, Telecommunications Engineer, Electronics
First Energy Corporation/Ohio Edison, Massillon, Ohio

**Michael Bentley**, Maintenance Supervisor
Merillat Industries, Jackson, Ohio

**Steve Combs**, Training Coordinator, Electrical Department
Delphi Harrison, Dayton, Ohio

**Rick Fath**, Facilities Manager, Maintenance
XTek, Inc., Cincinnati, Ohio

**Hadley Kline**, President
Cuyahoga Plastics, Cleveland, Ohio

**Robert C. Mitchell**, President
Mitchell Electrical Contracting/RCM Construction, Inc., Steubenville, Ohio

**Ruel Mitchell**, Vice President
Mitchell Electrical Contracting/RCM Construction, Inc., Steubenville, Ohio

**Glenn Myres**, Senior Electrical Engineer
Malcolm Pirnie, Inc., Columbus, Ohio

**Craig A. Petrella**, Training Specialist, Craft & Apprentice Training, H.R.
Weirton Steel Corp., Weirton, West Virginia

**Lance Rehberg**, Supervisor, Tech. Adm., Drawing Management
Sprint, Mansfield, Ohio

**Keith Rosnell**, President/CEO
MBS Engineering Solutions, Cincinnati, Ohio

**Steven Schmidt**, Director, Engineering
APSCO Inc., Perry, Ohio

**Bob Sintobin**, Lab Tech, Elec/Mech
Toledo Technology Academy/Sears, Toledo, Ohio

**Alan Smith**, Assistant Engineering Manager
Creative Control Designs, Inc., Reynoldsburg, Ohio

**Eugene Stepanik**, Training Director, Electrical Department
Cleveland Electrical JATC, Valley View, Ohio

**Jeff R. VanZant**, QC, CNC Program Purchasing Supervisor, Industrial Manufacturing Tech.
Houston Machine Products, Inc., Springfield, Ohio

**Mark Winnett**, Director, Order Fulfillment, Plant Operations
DAYCO Products, Inc., Swan Hose Plant, Retail Business Unit, Bucyrus, Ohio

# Engineering Technologies
# State Competency Profile Meeting

## Educator Panel

**David Ackerman**, Electronics Instructor
Belmont Harrison JVS, St. Clairsville, Ohio

**Jan Adams**, Coordinator, Tech-Prep Educational Partnerships, Applied Science
Firelands College - BGSU, Huron, Ohio

**David Andrews**, Vocational Education Teacher
Patterson Career Centers, Dayton Public Schools, Dayton, Ohio

**Robert Ballinger**, Vocational Electronics Educator
Perry High School, Massillon, Ohio

**Patrick Beech**, CADD Drafting Instructor, T&I
Madison High School, Mansfield, Ohio

**Dave Bittner**, Engineering Technology Educator
Lakeland Community College, Kirtland, Ohio

**Steve Bowman**, Quality Support Leader & Supervisor, T&I
Great Oaks Institute of Technology & Career Development, Cincinnati, Ohio

**Tracy Burden**, Correlated Math Teacher
Madison High School, Mansfield, Ohio

**David Campbell**, Electronics Instructor
Northwest Career Center, Cincinnati, Ohio

**Wayne Caudill**, Math/Science Teacher
Muskingum-Perry Career Center, Mid-East Ohio Vocational School District, Zanesville, Ohio

**George Clonch**, Manufacturing Educator
University of Rio Grande, Rio Grande, Ohio

**Dave Copsey**, Electronics Instructor, Career & Technology
Clay High School, Oregon, Ohio

**Tom Currie**, Chair, Electronic Engineering Technology
Columbus State Community College, Columbus, Ohio

**Jim Davis**, Associate Professor, EET
Muskingum Technical College, Zanesville, Ohio

**Ky Davis**, Mathematics Instructor
Muskingum Technical College, Zanesville, Ohio

**Tim Dean**, Electrical Instructor, T&I
Madison High School, Mansfield, Ohio

**David Devier**, Dean, Industrial & Engineering Technologies
Owens Community College, Toledo, Ohio

**Ray A. DiPilla**, Program Chair, Electro-Mechanical Engineering Technology
Cincinnati State Technical & Community College, Cincinnati, Ohio

**Matthew Dudas**, Electronics Instructor
Muskingum-Perry Career Center, Zanesville, Ohio

**Daniel Durfee**, Professor, Engineering & Science, Environmental Department
Muskingum Technical College, Zanesville, Ohio

**Michael Dyer**, Manufacturing Educator
Buckeye Hills Career Center, Rio Grande, Ohio

**Maxine Ewig**, Project Director
Toledo Technical Academy, Toledo, Ohio

**Sophie Garrity**, Science Teacher
Belmont Career Center, St. Clairsville, Ohio

**Nancy K. Gilson**, English Professor
Marion Technical College, Marion, Ohio

**Thurman Grass**, EET Coordinator
Lima Technical College, Lima, Ohio

**Mike Haines**, Tech Prep Electronics Teacher
Auburn Career Center, Concord Township, Ohio

**Herbert Hall**, Chair, Electronics Technology, EET
Lakeland Community College, Kirtland, Ohio

**Connie Hilty**, Applied Communications/English
Muskingum-Perry Career Center, Zanesville, Ohio

**Steve Jefferson**, CADD Drafting Instructor
Know County Career Center, Mt. Vernon, Ohio

**Doug Kepp**, Chair, Computer Integrated Manufacturing
Lakeland Community College, Kirtland, Ohio

**Jason S. Kernahan**, Industrial Arts/Tech Prep Manufacturing Instructor
Buckeye Local High School, Rayland, Ohio

**Deb Knigga**, Communications Administrator
Firelands College - BGSU, Huron, Ohio

**Michael Kouse**, Electronics Instructor
Ohio Hi-Point Career Center, Bellefontaine, Ohio

**Brian Kelly Kurth**, Engineering/Mathematics Instructor
Belmont Technical College, St. Clairsville, Ohio

**James Laremore**, Curriculum Chair, Engineering Technology, Science & Communications Division
Terra Community College, Fremont, Ohio

**Tecca Larrick**, Engineering Technology Teacher
Buckeye Career Center, New Philadelphia, Ohio

**Debbie Massari**, Assistant Professor, Mathematics
Cuyahoga Community College, Parma, Ohio

**Kathleen McCabe**, English Professor
Terra Community College, Fremont, Ohio

**Kerry McClure**, Instructor, Architecture/Construction Management
Eastland Vocational Satellite, Gahanna Lincoln High School, Gahanna, Ohio

**Jim McIntyre**, Engineering Technology Teacher
EHOVE Vocational School, Milan, Ohio

**Terry Metz**, Associate Professor, Physics/Engineering Technology
Marion Technical College, Marion, Ohio

**Donald Moran**, Engineering Instructor
Central Ohio Technical College, Newark, Ohio

**Robert Morley**, Tech Prep Instructor
Jefferson County JVS, Bloomingdale, Ohio

**James Mumaw**, Teaching/Learning Chair, Electronics Technology, Science & Communications Division
Terra Community College, Fremont, Ohio

**Michelle Olecki**, English Teacher
Madison High School, Mansfield, Ohio

**Richard Patterson**, Tech Prep Instructor, Engineering
Trumbull County JVS, Kent State University, Warren, Ohio

**Harold Pearson**, Professor, Robotics
Sinclair Community College, Dayton, Ohio

**Mark D. Pumphrey**, Manufacturing Engineering Technology Instructor
Muskingum-Perry Career Center, Mid-East Ohio Vocational School District, Zanesville, Ohio

**Ron Quillen**, Department Head, Industrial Engineering
Stark State College of Technology, Canton, Ohio

**Ritch Ramey**, Tech Prep Instructor, Engineering
Marion Technical College, Marion, Ohio

**John W. Romick**, Industrial Manufacturing Coordinator
Belmont Career Center, St. Clairsville, Ohio

**Joel Rudinger**, Engineering Professor
Firelands College - BGSU, Huron, Ohio

**Les Ryle**, OWA Teacher/Coordinator
Elgin Local Schools, Marion, Ohio

**Brent Sanders**, Principles of Technology Teacher, T&I
Madison High School, Mansfield, Ohio

**Carmen Santone**, Tech Prep Instructor, Engineering
Trumbull County JVS, Kent State University, Warren, Ohio

**Mike Smith**, Engineering Design Teacher
Hamilton City Schools, Hamilton, Ohio

**Brian Sneider**, Industrial Technology Teacher
Technology Center, Vanguard-Sentinel JVSD, Fremont, Ohio

**Ronald Summers**, Senior Teacher, Tech Prep Manufacturing
Springfield-Clark JVS, Springfield, Ohio

**Dale Toukonen**, Instructor, Tech Prep Computer Integrated Manufacturing Technology
Auburn Career Center, Concord Township, Ohio

**Robert Walder**, Associate Professor, Engineering Technology
Clark State Community College, Springfield, Ohio

**Rudy G. Wojtecki**, Assistant Professor, MERT
Kent State University, Trumbull Campus, Warren, Ohio

**Jeff Woodson**, Faculty, Mechanical Engineering Technology
Columbus State Community College, Columbus, Ohio

**Alexandria S. Yavelak**, Applied Math/English Teacher
Belmont-Harrison Career Center, St. Clairsville, Ohio

**Tom Yeater**, Engineering Program Director
North Central Technical College, Mansfield, Ohio

**Don Yetzer**, Tech Prep Instructor, Engineering Design, T&I
Colerain Career Center, Cincinnati, Ohio

# LEVELING CODES

## GRADE LEVEL

12 = by the end of grade 12

AD = by the end of the Associate Degree

## DEPTH

I = Introduce (applies to at least three or 25% of the competency builders)

R = Reinforce or add depth (after introducing or proficiency)

P = Proficient (achievement of the competency **without** supervision)

## ACADEMIC CODES

C = Communications related

M = Mathematics related

S = Science related

## OTHER (Determined by Business, Industry and Labor Panel)

**Essential Competency:** Competency is needed to ensure **minimal** level of employability. Entry level employees should be able to perform this competency without supervision. Competencies required for certification, licensure, and/or national skills standards should be tagged as essential.

**Recommended Competency:** Competency should be included but is not essential for minimal level of employability.

**Delete:** Competency should not be included.

---

## Example:

**BIL:** Essential Recommended Delete

|  | 12 | AD | AC |
|---|---|---|---|
| **EDU** | P | R | C |

**Competency:** XXXXXXX

## Example:

**BIL:** Essential Recommended Delete

|  | 12 | AD | AC |
|---|---|---|---|
| **EDU** | P | R | C |

**Competency:** YYYYYYY

**Competency Builders:**

SSS

XXX M

# Occupational Definitions
# Engineering Technologies

**Electronics Technician—An individual who combines electrical, electronic, and mechanical functions and their interactions. Technical skills should include, but not be limited to:**

- quality control and safety devices
- microcomputer applications in industry
- electronic applications of communication equipment
- teamwork skills
- report preparation

**Electrical Maintenance Technician—An individual who applies basic engineering principles and technical skills supporting electrical, electronics, and communication engineers. Technical skills should include, but not be limited to:**

- electrical circuitry
- prototype development and testing
- systems analysis and testing
- systems maintenance and repair
- instrument calibration
- teamwork skills
- report preparation

**Electromechanical Systems/Electrical Maintenance Technician—An individual who applies electrical theory and related knowledge to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial settings. Technical skills should include, but not be limited to:**

- causes of electrical or mechanical malfunction or failure of equipment
- preventative and corrective maintenance
- equipment modification and/or replacement
- mechanical and electrical equipment and systems testing, troubleshooting, repair, and modification
- test data analysis and interpretation
- adjustment, calibration, alignment, and modification of circuitry and components
- teamwork skills
- report preparation

**Industrial Manufacturing Technician**—**An individual who applies basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and/or using manufacturing systems and processes. Technical skills should include, but not be limited to:**

- machining skills
- print and schematic interpretation
- geometric dimensioning and tolerancing
- basic CADD skills
- basic electrical skills
- computerized numerical control
- programmable logic controllers
- operational diagnosis, repair, and maintenance procedures
- manufacturing methods specification and implementation
- statistical process control
- teamwork skills
- report preparation

**CADD Technician**—**An individual who applies technical knowledge and skills to plan and prepare computerized pictorial interpretations of plans and design concepts for mechanical devices and machinery. Technical skills should include, but not be limited to:**

- print and schematic interpretation
- proficient drafting and CADD/CAM skills
- drawing designs from approved sketches
- drawing designs from blueprints, designs, mockups, and photoprints
- layouts, drawings, and schematics depicting function, relationship, and assembly sequence of parts and assemblies
- teamwork skills
- report preparation

## Engineering Technologies Cluster

| | | | |
|---|---|---|---|
| **ET =** | Electronics Technician | **IM =** | Industrial Manufacturing Technician |
| **EM =** | Electromechanical Systems/Electrical Maintenance Technician | **CT =** | CADD Technician |

| Small Type | Large Type | UNIT | ET | EM | IM | CT |
|---|---|---|---|---|---|---|
| 1 | 1 | Employability Skills | X | X | X | X |
| 11 | 16 | Professionalism | X | X | X | X |
| 21 | 27 | Teamwork | X | X | X | X |
| 25 | 36 | Professional Practices | X | X | X | X |
| 29 | 41 | Workplace Safety | X | X | X | X |
| 31 | 45 | Project Management | X | X | X | R |
| 36 | 50 | Problem Analysis | X | X | X | X |
| 39 | 53 | General Administrative Functions | X | X | X | X |
| 43 | 57 | Economic and Business Principles | X | X | X | R |
| 53 | 69 | Basic Computer Concepts and Applications | X | X | X | X |
| 74 | 97 | Quality Assurance | X | X | | X |
| 94 | 126 | Quality Assurance for IM | | | X | |
| 109 | 148 | Technical Recording and Reporting | X | X | X | X |
| 111 | 152 | Supervision | | R | R | R |
| 113 | 155 | Drafting Technology for IM and CT | | | X | X |
| 126 | 173 | Drafting Technology for ET and EM | X | X | | |
| 132 | 181 | Visualization and Design for Function | | | X | X |
| 134 | 183 | CADD Fundamentals | X | | R | X |
| 142 | 193 | Intermediate CADD | X | | | X |
| 145 | 196 | Advanced CADD | | | | X |
| 154 | 209 | Basic Electricity | X | X | X | |
| 158 | 217 | Fundamentals of Electronics Technology | X | X | | |

R = Recommended

**ET =** Electronics Technician
**EM =** Electromechanical Systems/Electrical Maintenance Technician
**IM =** Industrial Manufacturing Technician
**CT =** CADD Technician

| Small Type | Large Type | UNIT | ET | EM | IM | CT |
|---|---|---|---|---|---|---|
| 161 | 223 | Electronic Noise | X | X |  |  |
| 164 | 226 | Analog Circuits | X | X |  |  |
| 169 | 232 | Digital Logic Circuits | X | X |  |  |
| 173 | 236 | Microcomputer Electronics Technology | X |  |  |  |
| 178 | 244 | Instrumentation Control Technology | R | X |  |  |
| 185 | 252 | Electro-optic Technology | X | X |  |  |
| 190 | 259 | Electronics Troubleshooting and Repair | X | X |  |  |
| 198 | 268 | Electronics Troubleshooting and Repair for IM |  |  | X |  |
| 200 | 271 | Electronic Product Servicing Technology | R |  |  |  |
| 207 | 281 | Programmable Logic Controllers (PLCs) | R | X | R |  |
| 211 | 287 | Communications Electronics Technology for ET | R |  |  |  |
| 220 | 298 | Communications Electronics Technology for EM |  | X |  |  |
| 227 | 308 | Industrial Electricity | X | X | X |  |
| 235 | 322 | Wiring Methods |  | X |  |  |
| 246 | 334 | Electrical Test and Measurement Equipment | X | X | X |  |
| 248 | 338 | Electronic Assembly and Repair | X |  |  |  |
| 251 | 342 | Equipment Installation |  | X | X |  |
| 256 | 348 | Equipment Maintenance | R | X | X |  |
| 263 | 360 | Industrial Engineering Basics |  |  | X |  |
| 267 | 367 | Industrial Manufacturing Technology |  |  | X |  |
| 273 | 375 | Basic Materials Science |  |  | X | R |
| 285 | 394 | Mechanical Power Transmission |  | X | X |  |
| 299 | 413 | Fundamentals of Machine Anatomy |  | X | X |  |
| 301 | 416 | Electromechanical Technology | R | X |  |  |

R = Recommended

**ET =** Electronics Technician
**EM =** Electromechanical Systems/Electrical Maintenance Technician
**IM =** Industrial Manufacturing Technician
**CT =** CADD Technician

| Small Type | Large Type | UNIT | ET | EM | IM | CT |
|---|---|---|---|---|---|---|
| 310 | 430 | Electromechanical Technology for IM | | | X | |
| 319 | 444 | Hydraulics and Pneumatics | | X | X | |
| 336 | 464 | Hydraulics and Pneumatics for ET | X | | | |
| 340 | 469 | Computerized Numerical Control (CNC) for EM | | X | | |
| 343 | 473 | Computerized Numerical Control (CNC) for IM | | | X | |
| 350 | 481 | Precision Machining | | | X | |
| 366 | 504 | Metal Stamping Dies | | | R | |
| 376 | 514 | Press Technology | | | R | |
| 378 | 516 | Sheet Metal Fabrication | | | R | R |
| 383 | 522 | Basic Moldmaking | | | R | |
| 393 | 532 | Material Joining Technology | | | R | |
| 397 | 536 | Welding Basics | | | X | |

R = Recommended

## **Unit: Employability Skills**

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Develop a career plan # ***

**Competency Builders:**
Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to monetary)
Identify job requirements
Investigate education/training opportunities (including speaking with someone in the trade)
Identify and evaluate personal strengths and weaknesses
Refine a written educational plan which leads to a specific career field
Create career passport

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | P | R | C,S,M |

**Competency:** **Prepare for employment # ***

**Competency Builders:**

Identify employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities
Compare salary ranges and benefit packages
Compile occupational profile
Demonstrate ability to accurately complete a job application
Demonstrate verbal interpersonal communication
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Use proper diction in interviews
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions using simulated role playing exercises
Evaluate job offers
Give appropriate notice to employer of job change

Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Identify the importance of participating in extracurricular activities (e.g., student government, community projects)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Evaluate the importance of self-esteem as an employability skill # ***

**Competency Builders:**

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Demonstrate job retention skills # ***

**Competency Builders:**

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify appropriate methods for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (e.g., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Demonstrate knowledge of work ethic # ***

**Competency Builders:**
Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | P | R | C |

**Competency:** **Exhibit appropriate work ethic # ***

**Competency Builders:**
Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Apply decision-making techniques # ***

**Competency Builders:**

Identify decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision
Identify ownership of decision to be made
Identify risks

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Apply problem-solving techniques #**

**Competency Builders:**
Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action
Document results

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Exhibit characteristics for job advancement # ***

**Competency Builders:**
Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Respond appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

# Unit: Professionalism

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Project professional image # ***

**Competency Builders:**
Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individual's vital role in organization
Exhibit proper etiquette in professionally-related situations

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Formulate individual and professional goals # A ***

**Competency Builders:**

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C |

**Competency:** **Organize personal finances # ***

**Competency Builders:**
Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discretionary vs. non-discretionary expenditures

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,C,M |

**Competency:** **Support community well-being ***

**Competency Builders:**

Identify environmental, educational, and social issues

Participate in social and/or community/industry activities

Participate in industry activities and organization

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Contribute to organizational goals ***

**Competency Builders:**
Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organizational goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Demonstrate positive relations in the workplace # ***

**Competency Builders:**
Identify personality types
Identify methods of working with various personalities
Identify various management styles
Support organization expectations
Support organization decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Manage stressful situations**

**Competency Builders:**

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Identify positive methods to channel stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,S,M |

**Competency:** **Analyze effects of family on work and work on family**
#

**Competency Builders:**
Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C |

**Competency:** **Apply lifelong learning skills # ***

**Competency Builders:**
Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Manage professional development ***

**Competency Builders:**
Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

## **Unit: Teamwork**

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Demonstrate knowledge of teamwork # ***

**Competency Builders:**
Define self-direction
Define responsibility
Define accountability
Differentiate work groups and teams (e.g., internal, external)
Identify conditions essential to teamwork (e.g., problem solving)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of team members
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system
Define mutual respect
Define equality
Define group dynamics (group think)
Provide feedback
Receive feedback
Define communication styles
Define management styles
Define social style
Define continuous improvement

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Demonstrate teamwork # ***

**Competency Builders:**
Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members (e.g., talents, skills, abilities)
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Exhibit continuous improvement
Recognize failure as part of learning

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Use teamwork to solve problems # ***

**Competency Builders:**
Identify appropriate situations for using teams
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation (e.g., business plan & procedure)
Identify problem
Use problem-solving process in a team setting (e.g., Brainstorm, Paredo, Fishbone)
Identify resources
Gather data
Analyze data
Describe solution options
Implement solution options
Review solution
Review case studies
Document results

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C |

**Competency:** **Conduct team meetings ***

**Competency Builders:**

Plan agenda
Set ground rules (Roberts Rules of Order)
Schedule meeting and location
Set time limitations
Invite appropriate personnel
Set next team meeting
Solicit outside speakers as needed
Select scribe
Select meeting leader
Facilitate ground rules
Select facilitator
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, budget, time frame and accountability to tasks
Monitor time
Overcome team impasse
Close meeting on time
Publish minutes in timely manner
Avoid placing individual agendas above the group's agenda

## **Unit:** Professional Practices

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Explain professional responsibilities ***

**Competency Builders:**
Explain the need for professional and ethical standards
Explain responsibility of the individual to apply ethical standards
Identify responsibility to client(s) and employer(s)
Explain consequences of unprofessional and/or unethical behavior
Explain importance of conflict resolution in the workplace

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Identify legal and ethical behavior**

**Competency Builders:**

Differentiate between legal and ethical behavior

Explain terms, principles, and characteristics of legal and ethical behavior (e.g., loyalty, discretion, solicitation, competitor, supplier)

Explain legal ramifications of breaching rules and regulations

Explain effects of unethical and/or unlawful behavior

Practice within scope of the profession

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C,M |

**Competency:** **Function as a self-managed employee**

**Competency Builders:**
Propose project (C)
Organize tasks
Manage time
Meet deadlines
Maintain business records (C)
Make long-term and short-term plans
Evaluate progress
Report progress (C)
Delegate project
Acquire appropriate licenses/registrations
Obtain permits and releases

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Follow intellectual property rights and copyright laws**

**Competency Builders:**
Explain purpose of patent
Explain purpose of copyright
Explain purpose of licenses
Explain purpose of trademarks
Explain rights of the originator
Explain rights of the public
Define confidentiality
Define proprietary
Explain legal ownership of proprietary material
Describe stock image/text usage rights
Explain negotiation of contracts
Explain reproduction licensing and residual usage

## Unit: Workplace Safety

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Maintain safe working environment**

**Competency Builders:**

Describe what an MSDS sheet is
Comply with HMIS material safety data sheets (MSDS) and OSHA regulations
Comply with all MSDS regulations regarding hazardous materials
Maintain clean work area by removing waste, keeping alleyways clear, cleaning tools, and preventing spills
Minimize workplace causes of environmental burdening, pollutants, and poisoning
Describe pollution solution limits imposed by permits and regulations
Comply with regulatory guidelines in handling, labeling, and disposal of solutions (e.g., fountain chemicals, inks, wash-up solutions, drum grounding)
Identify visual equipment controls (e.g., monitors, read outs)
Identify auditory equipment controls
Comply with workplace safety rules and procedures
Comply with personal safety rules and procedures
Comply with applicable electrical, mechanical, hydraulic and pneumatic safety rules and procedures
Recycle appropriate materials
Use preventive maintenance checklists
Identify location of control panels, shut-off valves, and fire extinguishers

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S |

**Competency:** **Demonstrate knowledge of ergonomics**

**Competency Builders:**

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle/physical force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (e.g., centering one's view of everything around man) design

## **Unit:** Project Management

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Explain project management ***

**Competency Builders:**

Identify project purpose/goal
Identify project objectives
Identify work breakdown structure (WBS)
Identify resource requirements
Identify project economics/funding
Identify risks

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Plan projects ***

**Competency Builders:**
Apply responsibility assignment matrix (RAM)
Apply Gantt or bar charts
Apply network diagrams
Apply critical path method (CPM)
Apply project education and review techniques (PERT)
Apply software programs

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M,S |

**Competency:** **Implement projects ***

**Competency Builders:**
Monitor project
Control project
Modify project

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M,S |

**Competency:** **Evaluate projects ***

**Competency Builders:**
Analyze performance
Perform critical review of project
Draw project management conclusions

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Write project summary ***

**Competency Builders:**
List project goals
Document project's key successes
Document project's key failures
Analyze costs vs accomplishments

## **Unit: Problem Analysis**

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,C,S |

**Competency:** **Appraise situations #**

**Competency Builders:**
Identify concerns
Set priorities
Identify resolution process
Plan resolution

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Analyze problems #**

**Competency Builders:**

Identify potential problems
Identify likely causes
Test for probable causes
Verify cause
Identify preventive actions
Identify contingent actions

**BIL:** Recommended

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | M,C,S |

**Competency:** **Analyze decisions #**

**Competency Builders:**
Identify objective(s)
Identify alternatives
Evaluate alternatives
Assess risks
Make final choice
Determine effectiveness of decision
Document results

## Unit: General Administrative Functions

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,C,S |

**Competency:** **Maintain work flow #**

**Competency Builders:**
Organize work
Prioritize work
Apply time-management techniques
Complete assigned tasks in a timely manner
Coordinate with team members

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Perform telecommunications operations #**

**Competency Builders:**
Display telephone etiquette
Operate equipment
Listen assertively
Verify information
Record messages
Place calls
Organize teleconferences
Use voice mail/messaging systems
Operate fax/modem machine
Use e-mail systems
Use Internet communications services
Use videoconference facilities

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,M |

**Competency:** **Perform scheduling functions #**

**Competency Builders:**

Create calendar/schedule

Maintain and use appointment calendars with accurate addresses and phone numbers

Process requests for appointments

Verify appointments

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Manage records #**

**Competency Builders:**
Implement filing system
Implement retention system
Perform electronic filing operations
Maintain inventory records
Retrieve files

## Unit: Economic and Business Principles

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | M,C |

**Competency:** **Describe basic economic concepts # ***

**Competency Builders:**

Identify importance of economic resources
Explain concept of economic resources
Explain importance of economic resources
Explain concept of economic goods and services
Differentiate between economic goods and services
Differentiate between needs and wants
Explain concept of supply and demand
Explain concept of price
Explain how supply, demand, and price are related
Explain concept of private enterprise and business ownership
Explain concept of profit
Explain concept of risk
Explain concept of competition
Explain relationship among risk, competition, and profit
Describe global economic and world markets
Describe economic cycles (e.g., unemployment, recession, inflation, budget deficits)
Describe economic arena's effect on business (e.g., financial, competitor indicators, industry)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Describe economic systems # ***

**Competency Builders:**

Describe free enterprise system
Describe relationship between government and business
Describe relationship between labor and management
Compare types of economic systems

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Understand income statement data # ***

**Competency Builders:**
Identify revenue
Identify overhead expenses
Identify fixed expenses
Identify direct labor
Identify indirect labor
Identify direct and indirect materials
Identify general and administrative expenses
Identify selling expenses
Identify net income

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Explain equipment depreciation ***

**Competency Builders:**
Explain straight line
Explain sum of year's digits
Explain declining balance
Explain IRS strategies

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Identify cost and profit influences ***

**Competency Builders:**
Explain importance of loss prevention
Explain importance of maximizing quality
Explain importance of maximizing productivity
Differentiate between specialized training and cross training
Explain labor, management, and government influences on cost /profit
Explain cost/profit influences of retraining
Define impact of seasonal business cycles

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Describe economic indicators and trends # A ***

**Competency Builders:**
Define gross national product and gross domestic product
Define national debt
Define impact of interest rates
Define impact of government spending
Define impact of seasonal business cycles
Define impact of inflation, growth, recession, and unemployment
Define impact of national and world events
Define impact of the growth of international trade

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Explain international trade ***

**Competency Builders:**
Describe nature and importance of international trade
Explain marketing in international trade
Explain balance of trade concepts
Describe impact of foreign investment
Describe the influence of national debt
Describe the effect of currency exchange rates on international trade

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C,M |

**Competency:** **Explain basic business concepts ***

**Competency Builders:**
Identify functions of business
Explain role of management
Explain role of labor
Explain concept of service as a product
Explain role of administration
Explain role of operations
Identify role of company objectives
Identify importance of ethical business practices
Identify types of ownership
Identify components of a business plan
Calculate break even and payback
Explain role of depreciation in business decisions
Explain role of capital gains
Describe business reporting and information flow
Map interface of departmental functions
Describe business communication channels (e.g., formal, informal)
Explain basic total quality management (TQM/ISO) principles
Explain the effects of bankruptcy

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Explain legal concepts ***

**Competency Builders:**

Define legal terminology

Explain business law concepts

Identify contracts and/or legal documents

Explain relationship of laws and regulations to company contracts, policies, and procedures

Identify laws relating to working conditions, wages and hours, civil rights, social security, disability, unemployment insurance, and exempt vs. nonexempt

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | C,M |

**Competency:** **Explain role of marketing # ***

**Competency Builders:**

Identify aspects of sound business image
Explain purposes of marketing
Describe functions of marketing
Describe effects of marketing
Identify target markets
Define sales potential
Explain pricing strategies
Differentiate among advertising campaigns
Explain functions of advertising agencies
Describe sales incentive programs
Differentiate among types of marketing strategies (e.g., phone, mail, person)

# **Unit:** Basic Computer Concepts and Applications

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S |

**Competency:** **Describe personal computer operations # ***

**Competency Builders:**

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage devices
Identify types of memory
Describe back-up and archival disciplines

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Explain information processing cycle ***

**Competency Builders:**

Describe computer languages and their use (e.g., machine, postscript, proprietary, graphic description)
Describe difference between data files and program files
Explain PC/Mac layout
Explain PC/Mac network layout
Explain mini/mainframe network layout
Differentiate among hardware, software, and firmware
Differentiate between open from proprietary architecture
Explain upload/download

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Explain operating systems # ***

**Competency Builders:**

Identify operating systems and their attributes (e.g., DOS, Unix, Macintosh, Windows)
Describe compatibility issues
Identify cross-platform file conversion tools
Describe how commands handle tasks in operating systems
Describe various input/output systems
Describe the purpose of operating system utilities
Differentiate between a compiler and an interpreter

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Demonstrate basic computer literacy # ***

**Competency Builders:**
Create directories/folders and sub-directories
Format disks
Manipulate files (copy, rename, delete)
Keyboard proficiently by touch

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Operate computer hardware # ***

**Competency Builders:**

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., printers, modems, touch screen, digitizers, plotters, graphic tablets, scanners, film recorders, video, laser image setters)
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques
Maintain usage and maintenance logs

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Explain operation of peripheral devices # ***

**Competency Builders:**

Identify peripherals and operating requirements of each
Identify primary devices used for personal computer auxiliary storage
Describe how data is stored on diskettes and hard drives
List speed and storage capacities of computer auxiliary storage devices
Describe attributes of diskettes and hard disks regarding speed and storage capacity
List types of disk storage used with large computer systems
Define role of tape storage in relation to personal and large computers
Describe security issues related to peripheral devices
Explain purpose of input devices (e.g., keyboard, mouse, scanners, pens, bar code readers, credit/debit/smart cards, voice, video, gloves)
Describe operation of output devices (e.g., voice, speaker output devices, printers, plotters, printer sharing units, SCSI interface, video display)
Describe operation of multimedia (e.g., video, audiosound)
Describe operation of storage devices (e.g., tape, disk, CD-ROM)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | |

**Competency:** **Operate peripheral devices # ***

**Competency Builders:**

Use appropriate reference materials
Load media devices
Start media devices
Unload media devices
Import, edit, and export video and audio
Set up print devices
Operate scanner devices
Operate print devices
Maintain print devices
Monitor peripheral equipment operations
Perform routine maintenance on peripheral devices
List appropriate control procedures
Transmit via modem
Receive via modem
Search a CD-ROM library
Print information from a CD-ROM library
Describe device driver

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P |  |

**Competency:** **Store media # ***

**Competency Builders:**
Identify need for data library
Retrieve stored media (e.g., on-line, off-line, permanent, off-site)
File stored media (e.g., on-line, off-line, permanent, off-site)
Initialize media
Catalog media

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Explain software applications # ***

**Competency Builders:**
Define software types and functions
Describe need for application software
Describe different types of software applications
Explain advantages and disadvantages of integrated and dedicated software
Differentiate features between like applications
List software sources
Explain software copyright laws
Explain data compression techniques
Explain use of passwords/security
Explain desktop productivity tools

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Use word processing packages # ***

**Competency Builders:**
Define word processing terminology
Explain functions of word processing software
Explain word processing applications
Use appropriate reference materials including on-line help
Keyboard efficiently by touch
Use mouse
Initialize diskette
Prepare backup file
Maintain backup file
Update spelling dictionary and spell check
Perform document functions (e.g., locate, rename, delete, save, retrieve, copy)
Perform formatting functions (e.g., center, underline, bold, cut and paste)
Perform redlining functions
Use edit features
Use sort features
Add page numbers to document
Add headers and footers
Print files, pages, screens and blocks of text
Verify accuracy of output
Create a document
Save a document to disk
Retrieve a document from disk
Edit an existing document
Describe word-wrap
Print a document
Store boilerplate material (e.g., templates, stationary files)
Compose documents at keyboard

Tabulate multiple columns
Prepare new documents from existing ones
Merge selected copy with new information
Prepare various types of table options
Format text
Integrate database, spreadsheet and graphic files
Convert documents from one system/version to another
Demonstrate use of computer thesaurus
Use multimedia techniques/resources
Perform merge functions

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | S |

**Competency:** **Use spreadsheet packages # ***

**Competency Builders:**
Define spreadsheet
Explain basic spreadsheet terminology
Define components of spreadsheets
Describe implementation of spreadsheet operations in business scope
Use mouse
Use spell check
Execute an electronic spreadsheet
Enter data, formulas, and functions
Differentiate between labels and numbers
Speculate using "what if..." questions
Sequence keystrokes in the creation of a macro
Create database within spreadsheet
Perform data query functions
Move around in spreadsheet and correct errors
Create links to other files
Format spreadsheet
Create graphs
Print graphs
Save previously saved files
Load previously saved files
Replicate cells using copy commands
Use electronic spreadsheet to complete business application
Use spreadsheet to plan financial strategies
Prepare spreadsheet
Use multimedia techniques/resources

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,C |

**Competency:** **Use databases # ***

**Competency Builders:**

Define database
Explain terms used in database systems
Describe common functions of database systems
Use database to design, create, input, edit, and display fields and records
Analyze structure of database files
Perform calculations with a database file
Alter structure of database file
Sort records based on multiple fields
Identify advanced database technology
Use appropriate reference materials
Utilize relational database
Enter elements into database
Proofread database
Explain database
Design report formats
Import/export data from alternate file formats
Transfer data to and from remote database
Link data to and from remote database
Print reports using data from multiple databases
Use database files with other application software
Verify accuracy of output (e.g., edit reports)
Query databases

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Use graphic user interface (GUI) techniques # ***

**Competency Builders:**
Describe a variety of computer interfaces
Explain multi-tasking environment
Use general navigational skills
Use cut and paste functions

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Manage software packages # ***

**Competency Builders:**
Install software packages
Upgrade software packages
Document installation and upgrade of software packages
Apply security levels/procedures to sensitive data
Manage software preferences
Manage software conflicts
Identify system requirements
Identify licensing issues

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Maintain computer security requirements # ***

**Competency Builders:**
Apply business ethics
Follow security rules, regulations, and codes
Implement security procedures
Document security procedures
Perform security audits

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Maintain personal computer systems # ***

**Competency Builders:**

Monitor system status and performance
Run diagnostics, utilities, and anti virus
Report computer system malfunction(s)
Report software malfunction(s)
Identify corrupted files and recovery procedures
Maintain security
Maintain hardware/software inventory
Perform backup procedure(s)
Perform preventive maintenance
Demonstrate file management techniques
Follow log-off and power-down procedure(s)
Follow equipment maintenance procedures
Follow quality control procedures

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C |

**Competency:** **Demonstrate basic knowledge of networks # ***

**Competency Builders:**
Explain communications standards
Describe network structures
Explain network types and protocols
Explain network connectivity
Explain the function of servers in a graphic network
Describe various network operating systems
Explain the difference between network software and individual use software
Use a network to access, file, and store files

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Use a shared environment # ***

**Competency Builders:**
List purposes of a network environment
Define electronic mail
Identify advantages and disadvantages of electronic mail
Describe impact of local & wide area networks on mail delivery
Compose electronic messages
Send electronic messages using appropriate format
List categories of electronic mail service
Transmit document using electronic mail system
Use collaboration tools
Monitor electronic mail
Use networked environments
Search database for properties of materials
Conduct literature searches using a variety of on-line tools
Explain access, security, transmission and retrieval

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C |

**Competency:** **Demonstrate knowledge of the Internet/Intranet ***

**Competency Builders:**
Define the Internet/Intranet
Explain how the Internet/Intranet works
Explain Internet/Intranet capabilities and limitations
Explain how to connect to the Internet/Intranet via modem, ISDN, etc.
Install Internet/Intranet software
Navigate the World Wide Web
Identify services and tools offered on the Internet/Intranet
Explain bookmarks
Describe security issues
Describe ethical use of the Internet/Intranet

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | P | R | C |

**Competency:** **Use the Internet/Intranet***

**Competency Builders:**
Define how the Internet can be used for research
Use services and tools offered on the Internet for research
Identify search engines
Use search engines
Evaluate Internet resources and accuracy of information
Access library catalogs on the Internet
Access commercial and government resources
Download files
Use other Internet/Intranet tools and services

## Unit: Quality Assurance

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Demonstrate knowledge of quality assurance**

**Competency Builders:**

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate between prevention and detection
Differentiate between variable and attribute data
Identify types of control charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C |

**Competency:** **Demonstrate knowledge of quality cost implications**

**Competency Builders:**

Identify cost/quality objectives
Classify costs (e.g., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (e.g., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define product liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate between expressed and implied warranty
Differentiate between warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C,M |

**Competency:** **Demonstrate knowledge of engineering a quality product**

**Competency Builders:**

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (e.g., preventive, evaluation, pre-delivery failures, post-delivery failures)
Describe predictive maintenance

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Explain importance of interdepartmental relationships to quality assurance**

**Competency Builders:**
Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Manipulate quality cost data**

**Competency Builders:**
Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C |

**Competency:** **Manipulate cost control data**

**Competency Builders:**
Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C |

**Competency:** **Demonstrate knowledge of basic statistics**

**Competency Builders:**
Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C |

**Competency:** **Demonstrate knowledge of scattergrams**

**Competency Builders:**
Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Demonstrate knowledge of probability theory**

**Competency Builders:**
Define classical probability
Define empirical probability
Calculate probability for outcomes

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Demonstrate knowledge of precontrol**

**Competency Builders:**
Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | R | M |

**Competency:** **Demonstrate knowledge of process capability**

**Competency Builders:**

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)

Calculate estimated process standard deviation

Plot right hand and left hand tail of process variation

Compute Z value for percent of probable defect for process

Calculate $C_{PK}$ values that describe process capability

Describe skewed distributions

List probable causes of skewed distribution

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Use quality control charts**

**Competency Builders:**

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Interpret X and R charts**

**Competency Builders:**
Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on X or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Construct X and R charts**

**Competency Builders:**

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute X (e.g., average of values) and R (e.g., range of values in subgroup) within sample
Plot in X and R on chart
Construct control chart with X (grand average) and R (average range) calculated
Calculate upper and lower control limits for X-chart
Calculate upper and lower control limits for R-chart

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C |

**Competency:** **Conduct process improvement studies**

**Competency Builders:**

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, $C_{PK}$)

Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)

Identify major steps in conducting a study

Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)

Integrate results into the total system

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Demonstrate knowledge of JIT**

**Competency Builders:**
Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification, and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems, and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Apply JIT**

**Competency Builders:**

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C |

**Competency:** **Demonstrate knowledge of inspection**

**Competency Builders:**
Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (e.g., poka-yoke)
Use checksheets to organize and record inspection results

**BIL:** Recommended

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | R | M |

**Competency:** **Inspect machinery, materials, and products**

**Competency Builders:**

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Demonstrate knowledge of nondestructive testing**

**Competency Builders:**
Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

## **Unit:** Quality Assurance for IM

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Demonstrate knowledge of quality assurance**

**Competency Builders:**

Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain importance of internal and external customers
Differentiate between prevention and detection
Differentiate between variable and attribute data
Identify types of control charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)
Define cost of quality

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Demonstrate knowledge of engineering a quality product**

**Competency Builders:**

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (e.g., preventive, evaluation, pre-delivery failures, post-delivery failures)
Describe predictive maintenance

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Demonstrate knowledge of basic statistics**

**Competency Builders:**
Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution
Identify sampling techniques

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Demonstrate knowledge of scattergrams**

**Competency Builders:**

Construct scattergram

Interpret for positive, negative, or no correlation between X and Y variables

Test for significance between one and five percent

Explain regression analysis

**BIL:** Recommended

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | R |  |

**Competency:** **Demonstrate knowledge of precontrol**

**Competency Builders:**
Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Demonstrate knowledge of process capability**

**Competency Builders:**

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate $C_{PK}$ values that describe process capability and CP
Describe skewed distributions
List probable causes of skewed distribution

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Use quality control charts**

**Competency Builders:**
Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Interpret X and R charts**

**Competency Builders:**
Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on X or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | | | |

**Competency:** **Construct X and R charts**

**Competency Builders:**

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute X (e.g., average of values) and R (e.g., range of values in subgroup)
    within sample
Plot in X and R on chart
Construct control chart with X (grand average) and R (average range) calculated
Calculate upper and lower control limits for X-chart
Calculate upper and lower control limits for R-chart
Identify various sampling plans and their use

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Conduct process improvement studies**

**Competency Builders:**

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, $C_{PK}$)

Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)

Identify major steps in conducting a study

Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)

Integrate results into the total system

**BIL:** Essential

| EDU: | 12 | AD | AC |
|---|---|---|---|
| | | P | |

**Competency:** **Demonstrate knowledge of JIT**

**Competency Builders:**

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification, and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems, and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Apply JIT**

**Comptency Builders:**

Maintain system for physical handling and movement of material in-process and in-storage

Monitor system of physical handling and movement of material in-process and in-storage

Maintain system for physical handling and movement of finished products

Monitor system of physical handling and movement of finished products

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Demonstrate knowledge of inspection**

**Competency Builders:**

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (e.g., poka-yoke)
Use checksheets to organize and record inspection results

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Inspect machinery, materials, and products**

**Competency Builders:**
Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Interpret instructions in a control plan

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Demonstrate knowledge of nondestructive testing**

**Competency Builders:**
Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

## Unit: Technical Recording and Reporting

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Demonstrate proficiency in technical recording**

**Competency Builders:**
Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Demonstrate proficiency in technical reporting**

**Competency Builders:**
Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

## Unit: Supervision

**BIL:** Recommended

| EDU: | 12 | AD | AC |
|---|---|---|---|
| | I | R | |

**Competency:** **Perform supervisory functions**

**Competency Builders:**
Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Identify human resources needed
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Coordinate training**

**Competency Builders:**
Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback
Monitor safety procedures
Interpret labor contracts
Document training

## Unit: Drafting Technology for IM and CT

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design.* 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 34-36.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Apply basic drafting skills**

**Competency Builders:**

Use drafting equipment
Identify line types (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control/revision block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare working drawings

Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements
Identify current ANSI symbols/standards

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Apply intermediate drafting skills**

**Competency Builders:**
Describe types of media and prints
Apply isometric, oblique, and perspective sketching techniques
Prepare isometric, oblique, and perspective sketches
Prepare sectional views
Prepare auxiliary views
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Describe purpose of auxiliary and sectional views
Dimension drawings per current ANSI standards

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | |

**Competency:** **Apply advanced drafting skills**

**Competency Builders:**
Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Interpret various drawings

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | |

**Competency:** **Interpret basic prints**

**Competency Builders:**
Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Interpret advanced prints**

**Competency Builders:**
Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Demonstrate knowledge of basic geometric dimensioning and tolerancing**

**Competency Builders:**

Identify geometric characteristics and symbols (e.g., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts
Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Convert dimensions and tolerances**

**Competency Builders:**

Convert dimensions and tolerances from English units to metric units

Convert dimensions and tolerances from metric units to English units

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Apply revision control process**

**Competency Builders:**

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | P | R | M |

**Competency:** **Demonstrate dimensioning techniques**

**Competency Builders:**
Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | M |

**Competency:** **Apply geometric dimensioning and tolerancing**

**Competency Builders:**
Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Interpret geometric dimensioning and tolerancing characteristic symbols
Interpret geometric dimensioning and tolerancing supplementary symbols
Apply symbols for maximum material control regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Prepare mechanical drawings**

**Competency Builders:**

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Prepare advanced mechanical drawings**

**Competency Builders:**
Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

# Unit: Drafting Technology for ET and EM

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design.* 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 34-36.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C |

**Competency:** **Apply basic drafting skills**

**Competency Builders:**

Use drafting equipment, measuring scales, drawing media, drafting instruments and materials, print duplicating equipment
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block/revision block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings

Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Interpret basic prints**

**Competency Builders:**
Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Interpret intermediate prints**

**Competency Builders:**
Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Convert dimensions and tolerances**

**Competency Builders:**
Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Demonstrate dimensioning techniques**

**Competency Builders:**
Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system
Interpret decimal tolerance dimensions
Calculate effects of dimensional stack-up

## Unit: Visualization and Design for Function

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Deduce by examination function(s) of parts**

**Competency Builders:**

Identify through examination the function of parts related to an automobile
Identify through examination the function of parts related to machine tools
Identify through examination the function of parts related to personal computers
Explain how function is related to part properties (e.g., geometry, material, finish)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Design/prepare computer model objects for function**

**Competency Builders:**
Develop an alternative design for an existing automobile part
Develop an alternative design for an existing machine tool part
Develop an alternative design for an existing computer part
Prepare a computer model of a house, warehouse, or other building
Prepare a computer model of a manufacturing process

# Unit: CADD Fundamentals

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 34-36.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Demonstrate basic use of computer operating system**

**Competency Builders:**

Explain rules for naming files and directories
Manage files
Create directories/subdirectories
Remove directories/subdirectories
Change directories/subdirectories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,C |

**Competency:** **Operate a CADD system**

**Competency Builders:**
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer, mouse)
Create scaled plots
Operate a printer/plotter (e.g., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Select entities for action**

**Competency Builders:**
Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Create 2-D orthographic drawings**

**Competency Builders:**
Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror)
Edit drawing entities (e.g., offset, trim, extend, break, mirror)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Annotate orthographic drawings**

**Competency Builders:**
Create text styles
Edit text styles
Select text styles
Apply notes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,M |

**Competency:** **Dimension orthographic drawings**

**Competency Builders:**
Apply dimensions per standards
Edit text
Control dimension variables/models

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Control display**

**Competency Builders:**
Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Extract entity and drawing information**

**Competency Builders:**
Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties)

# Unit: Intermediate CADD

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design*. 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 34-36.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Manage symbols and attributes**

**Competency Builders:**
Create blocks/cells/templates
Create nested blocks/templates/cells
Insert blocks and drawings/templates/cells
Redefine blocks/templates/cells
Edit blocks/templates/cells
Create/apply/modify attributes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Create 2-D isometric drawings**

**Competency Builders:**
Explain isometric projection
Manipulate isometric snap and grid settings
Toggle isometric planes (e.g., left, right, top)
Create text styles for each plane
Create dimension styles
Create isometric ellipses

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Use external/internal routines**

**Competency Builders:**
Load AutoLISP programs
Execute AutoLISP programs
Export CAD files
Import CAD files
Export text/graphic files
Import text/graphic files

## Unit: Advanced CADD

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the National Coalition for Advanced Manufacturing (NACFAM). Sources: *CADD: Computer Aided Drafting & Design.* 1996 Update and *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 34-36.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Create 3-D solid models**

**Competency Builders:**

Differentiate B-rep solid modeling and Constructive Solid Geometry (CSG) modeling
Create solid primitives
Modify solid primitives
Create swept solids
Use Boolean operations to create complex solids (e.g., unions, subtractions, intersections, separations)
Fillet solid models
Chamfer solid models
Extract mass properties from a solid model
Create 2-D profiles and sections from a solid model
Explain the limitations of solid modeling
List intersection properties

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Apply advanced display control**

**Competency Builders:**
Use clipping planes to section a model
Apply perspective views
Place camera and target points to locate views
Place lights for rendering
Control lights for rendering
Create rendered images of surface and solid models
Define camera viewpoints and angle of rotation
Control display angle (e.g., d-view, v-point)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | I | M |

**Competency:** **Write CADD sub-routines**

**Competency Builders:**

Perform simple math functions

Perform nested math functions

Write a routine which prompts for user input, performs calculations, and creates or edits geometry

Identify common error codes

Format a program to display balanced parentheses and nesting of functions

Write a program including an "if/then/else" statement

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Configure a CADD station**

**Competency Builders:**
Install CADD software
Configure display drivers
Configure printer/plotter drivers
Configure input drivers

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Prepare electrical/electronic CADD drawings**

**Competency Builders:**

Interpret basic electric/electronic standards and symbols
Prepare schematic drawings
Prepare cable drawings
Prepare component drawings
Prepare logic diagrams
Prepare control panel drawings
Prepare connection drawings
Prepare interconnection drawings
Prepare printed circuit board drawings
Prepare harness drawings
Prepare packaged drawings
Prepare wiring diagrams
Prepare enclosure drawings
Prepare installation drawings
Prepare flow charts
Prepare symbol library

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Prepare pneumatic/hydraulic CADD drawings**

**Competency Builders:**

Interpret basic pneumatic/hydraulic standards and symbols
Prepare piping drawings
Prepare isometric drawings
Prepare sectional diagrams
Prepare graphical symbols
Prepare process and instrumentation diagrams
Prepare combination diagrams
Prepare pump and motor drawings
Prepare cylinder and piston diagrams
Prepare valve drawings
Prepare pump section drawings
Prepare installation drawings
Prepare symbol library

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Prepare structural CADD drawings**

**Competency Builders:**

Use structural and reinforcing concrete manuals and technical tables
Detail structural beam connections
Detail concrete reinforcements
Prepare materials take off list
Draw structural framing plans and elevations
Identify welding symbols
Prepare symbol library

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | I | |

**Competency:** **Create custom menus and linetypes**

**Competency Builders:**

Demonstrate search routines when using a text editor
Write screen menus and macros
Write tablet menus and macros
Write cascading pop-down menus and macros
Write icon menus and macros
Write button menus and macros
Write other customizable CADD files (e.g., ACADD.PCP)
Edit other customizable CADD files (e.g., ACADD.PCP)
Formulate custom linetype
Formulate a linetype composed of long dashes
Formulate a linetype composed of lines, dashes, and dots

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Create 3-D models**

**Competency Builders:**

Differentiate between extrusions, wireframes, surface models, and solid models
Create user coordinate systems
Manipulate user coordinate systems
Use cylindrical coordinates
Use spherical coordinates
Use .XYZ filters
Project geometry from one plane to another
Define B-rep surfaces
Differentiate B-rep surfaces and non-uniform rational B-splines (NURB's)
Create tabulated surfaces
Create ruled surfaces
Create revolved surfaces
Create edge surfaces (e.g., coon's patch)
Apply surface meshes to 3-D wireframes
Modify visibility of the edges of faces
Dimension a 3-D model for both isometric and orthographic drawings
Control dimension scale with regard to plotting scale

## Unit: Basic Electricity

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | S,M,C |

**Competency:** **Demonstrate proficiency in electrical fundamentals**

**Competency Builders:**

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple and Peltier effects
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchhoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Demonstrate electrostatic discharge (ESD) preventative procedures

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | P | R | M,S,C |

**Competency:** **Demonstrate proficiency in DC circuits**

**Competency Builders:**
Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Operate power supplies for DC circuits
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principles of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate proficiency in AC circuits**

**Competency Builders:**

Analyze properties of an AC signal
Describe principles and operational characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operational characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operational characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operational characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings, and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operational characteristics of frequency selective filter circuits
Calculate gain (dB) using logarithmic tables or calculator/ computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning systems (e.g., isolation transformers, surge suppressors, uninterruptable power systems)

Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (f) and phase relationships
Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Explain simple AC generator action
Explain simple AC motor action
Calculate Power Factor in AC circuits
Explain Power Factor correction in reactive loads
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

# Unit: Fundamentals of Electronics Technology

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow.* June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Demonstrate proficiency in discrete solid-state devices**

**Competency Builders:**

Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC)
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,S,M |

**Competency:** **Describe manufacturing of electronic devices and micromechanisms**

**Competency Builders:**

List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Distinguish between analog and digital phenomena and circuits**

**Competency Builders:**

Describe the analog and digital measurement techniques of physical parameters (e.g., temperature, time, current, number of items coming down a production line)
Distinguish between an analog and a digital clock
Describe the instruments used to measure analog signals
Describe the instruments used to measure analog digital signals
Describe how an analog signal can be converted to a digital signal
Describe how an digital signal can be converted to an analog signal

# Unit: Electronic Noise

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Identify sources of electronic noise**

**Competency Builders:**

Define and explain intrinsic noise sources
Define and explain active and passive device noise
Explain conductively coupled noise
Explain common impedance noise coupling
Explain noise coupling by electric and magnetic fields

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C |

**Competency:** **Explain how to measure electronic noise**

**Competency Builders:**
Explain the use of "The Decibel" in noise characterization
Explain the standard "Noise Units" and weighing functions
Explain signal to noise ratios

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Explain techniques used to reduce electronic noise**

**Competency Builders:**
Explain noise reduction at the source
Explain noise coupling reduction
Explain noise reduction at the "Receiver"
Explain grounding techniques
Explain shielding techniques
Explain opto-electric isolation

## Unit: Analog Circuits

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Explain linear power supply regulator circuits**

**Competency Builders:**

Explain the need for voltage and current regulation

Explain how a fast linear regulator can reduce ripple

Define the output impedance of both an ideal and a practical voltage regulator

Define the output impedance of both an ideal and a practical current regulator

Explain how the linear voltage regulator can be made adjustable

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C,M,S |

**Competency:** **Describe linear power amplifiers**

**Competency Builders:**
Define a linear amplifier
Explain the use and operation of D.C. servo motor drivers
Explain the use and operation of audio power amplifiers
Explain what is meant by the bandwidth of power amplifiers
Explain the transient response of power amplifiers
Explain phase distortion in power amplifiers

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | M,C,S |

**Competency:** **Describe operational amplifiers**

**Competency Builders:**

Explain the significance of high open circuit gain
Explain the significance and characteristics of the summing junction
Explain offset and its adjustment
Explain the significance of differential inputs
Explain the unity gain buffer and line driver
Explain the analog voltage adder/subtractor
Describe/implement a current amplifier
Describe/implement a charge amplifier
Describe/implement an integrator
Define integrator "wind up"
Explain why "reset" is necessary in an integrator
Describe/implement a differentiator
Describe/implement a single pole low pass filter
Prepare a Bode plot for a single pole low pass filter

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Describe instrumentation amplifiers**

**Competency Builders:**

Explain how an instrumentation amplifier differs from a simple operational amplifier

Describe the signal types, levels, and environments that require instrumentation amplifiers for signal processing

Explain the significance of balanced input impedance

Demonstrate how an instrumentation amplifier can be constructed from operational amplifiers

Describe the characteristics of the resistors needed to make an instrumentation amplifier from an operational amplifier

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C |

**Competency:** **Describe analog active filters**

**Competency Builders:**
Describe need and uses of electronic active filters
Describe a single pole low pass filter
Describe a single pole high pass filter
Describe a band pass filter
Describe multi-pole low pass filters

## Unit: Digital Logic Circuits

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow.* June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Use binary arithmetic**

**Competency Builders:**

Identify features of positional numbering systems
Identify mathematical forms of notation
Perform number system conversions (e.g., binary to decimal, octal to binary)
Perform binary mathematical operations (e.g., addition, subtraction)
Use coded systems (e.g., BCD-Binary Coded Decimal)
Demonstrate binary code for decimal numerals 0-9

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Use Boolean algebra**

**Competency Builders:**

Explain basic functions of Boolean algebra
Identify signal levels that represent Boolean algebra
Perform Boolean operations
Write Boolean theorems
Draw light switching schematic circuits for OR, AND, NOT and exclusive OR
Draw logic diagrams For OR, AND, NOT, exclusive OR
Draw truth tables for OR, AND, NOT, and exclusive OR

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Explain digital logic elements**

**Competency Builders:**
Differentiate between types of digital logic families
Describe digital logic gates, AND, OR, NOT
Describe R-S (Reset-Set) flip-flops
Describe J-K clocked flip-flops
Describe shift registers
Describe encoders and decoders
Describe the binary full adder

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M |

**Competency:** **Explain digital logic and pulse circuits**

**Competency Builders:**

Implement the exclusive OR circuit using AND, OR, and NOT gates
Describe digital counters
Describe digital clocks and timers
Describe the schmidt trigger
Describe the monostable (single shot) multivibrator
Describe the astable (free running) multivibrator

## Unit: Microcomputer Electronics Technology

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow*. June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic proficiency in microcomputer systems**

**Competency Builders:**

Describe essential components of microcomputers and their functions
Describe principles and operation of BUS concepts (e.g., VESA, EISA)
Describe principles and operation of types of memory circuits
Identify operating systems (e.g., DOS, OS/2, UNIX)
Describe microprocessor instructions sets
Describe principles and operation of microprocessor machine code
Demonstrate use of microprocessor machine code
Disassemble microprocessor machine code
Identify types of input and output devices and peripherals
Describe principles and operation of storage devices
Interface input and output ports to peripherals
Demonstrate ability to interface peripherals
Identify central processing unit building blocks and their uses
Identify the levels of computer languages

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Demonstrate basic proficiency in computer systems architecture**

**Competency Builders:**
Describe the principles and operation of computer system architecture
Operate computer system architecture
Repair computer system architecture
Describe the principles and operation of addresses and interrupts
Describe the principles and operation of volatile and non-volatile memory
Demonstrate the use of volatile and non-volatile memory
Repair or replace volatile and non-volatile memory
Describe the principles and operation of advanced memory techniques
Define individual system blocks
Draw systems configuration in block detail
Interpret computer acronyms
Describe priorities and interrupts at systems level
Identify direct memory access data handling system(s)
Define functions of advanced memory techniques (e.g., virtual, pipeline, cache)
Troubleshoot a microcomputer system

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M |

**Competency:** **Demonstrate proficiency in software fundamentals**

**Competency Builders:**

Load operating system software
Run operating system software
Load diagnostic software
Run diagnostic software
Construct flow charts
Analyze flow charts
Explain computer languages and their uses
Write a simple computer program
Write program documentation
Describe firmware applications
Identify the need for backup
Describe security measures
Describe virus protection

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Describe elements of communication interfacing**

**Competency Builders:**

Define common EIA, IEEE, and CCITT communication standards (e.g., EIA 232 and 485, IEEE 488)
Identify sync devices
Identify async devices
Identify types of network (e.g., token ring, ethernet)
Identify networking levels or layers
Identify protocols
Identify packet switching
Identify multiuser systems
Operate network analyze devices
Identify network analyzer devices (e.g., breakout box, sniffers)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Describe peripheral equipment interfaces**

**Competency Builders:**

Define printer types and interface controllers
Explain the operation of typical magnetic tape equipment and interface controllers
Identify disk equipment and interface controllers
Define environmental requirements for peripherals and media

## Unit: Instrumentation Control Technology

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C,M |

**Competency:** **Describe instrument loops**

**Competency Builders:**

Use Instrumentation Society of America (ISA) symbology
Describe types of transducers (e.g., flow, level, pressure, temperature)
Describe transducer signal types and levels
Describe elements of a control loop (e.g., transmitter, indicator, controller, transducer, control valve)
Describe modes of control operation (e.g., manual, automatic, cascade, program)
Describe details of flow loop (e.g., orifice plate, segmental wedge, differential pressure transmitters (electronic and pneumatic), magnetic, turbine type transmitters, local indicators, controller, transducer, control valve)
Describe types of transducers used in level control loops
Describe details of pressure transducers
Describe details of temperature transducers (thermocouples and thermistors)
Describe details of infrared and photosensors
Describe details of proximity/vibration sensors
Describe details of speed/acceleration sensors
Describe details of resolvers and encoders
Describe details of linear voltage detection transformers (LVDT)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Calibrate loop elements**

**Competency Builders:**
Identify manufacturer's requirements
Identify loop requirements
Verify function of test equipment
Set up test procedure
Perform calibration
Record results

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Build control loops**

**Competency Builders:**
Build flow loop
Build level control loop
Build pressure loop
Build temperature loop

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Perform calculations**

**Competency Builders:**
Calculate orifice plate sizing
Calculate flow transmitter differential pressure
Calculate control valve sizing

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,C,S |

**Competency:** **Describe distributed control systems**

**Competency Builders:**
Describe various types of Input/Output (I/O) Signals
Describe various types of alarms
Describe system architecture

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Describe types of controller action**

**Competency Builders:**
Describe proportional control action (P)
Describe proportional and integral control action (PI)
Describe proportional, integral, and derivative control action (PID)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Perform loop tuning**

**Competency Builders:**

Troubleshoot loops

Demonstrate effect of using only a proportional parameter

Demonstrate effect of using only proportional and integral parameters

Demonstrate effect of various values for proportional, integral, and derivative tuning parameters

Demonstrate loop training using "open loop" step testing

Demonstrate loop tuning using Ziegler Nichols method

## Unit: Electro-optic Technology

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S |

**Competency:** **Demonstrate knowledge of light principles**

**Competency Builders:**

Describe the characteristics of light sources
Describe radiometric and photometric quantities in the measurement of light using light meters and related equipment
Describe the properties of light
Demonstrate the properties of light
Describe maximum permissible exposure (MPE)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S |

**Competency:** **Demonstrate knowledge of optical systems**

**Competency Builders:**

Describe the characteristics and properties of optical materials
Describe the use of optical components (e.g., lenses, beam splitters)
Describe the principles and operation of optical systems (e.g., ray tracing, refraction)
Demonstrate the use of optical systems (e.g., convergence, focusing, divergence)
Troubleshoot optical systems
Describe the advantages and disadvantages of fiber optics

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | S |

**Competency:** **Demonstrate knowledge of lasers**

**Competency Builders:**
Describe the principles of laser operations (e.g., population inversion, coherence)
Describe laser classifications
Describe the principles and operation of powering and pumping lasers
Describe temporal characteristics
Describe spatial characteristics
Describe laser safety

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S |

**Competency:** **Describe laser energy applications**

**Competency Builders:**

Describe the principles and operation of ion lasers
Describe the principles and operation of solid lasers
Describe the principles and operation of semiconductor lasers
Describe the principles and operation of dye lasers
Describe the principles and operation of lasers in welding, cutting, and drilling
Describe the principles and operation of lasers in data recordings and manipulating
Describe the principles and operation of lasers in environmental testing and monitoring
Describe the principles and operation of lasers in nondestructive testing
Describe the principles and operation of lasers in range finding, alignment and angle testing
Describe the principles and operation of fiber optics in laser systems
Describe the principles and operation of a laser in a communication system
Describe the advantages and disadvantages of fiber optics
Describe the principles of using lasers in medicine
Describe the principles of using lasers in holography/ interferometry

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | R | S |

**Competency:** **Perform laser applications**

**Competency Builders:**

Demonstrate the operation of various ion lasers
Demonstrate the operation of solid lasers
Demonstrate the operation of semiconductor lasers
Demonstrate the operation of dye lasers
Demonstrate CW and pulsed operation
Demonstrate the use of lasers in welding, cutting, and drilling
Demonstrate the use of lasers in data recording and manipulating
Demonstrate the use of lasers in environmental testing and monitoring
Demonstrate the use of lasers in nondestructive testing
Demonstrate the use of lasers in range finding, alignment, and angle testing
Demonstrate the use of a laser communication system
Troubleshoot laser applications
Repair laser applications

## Unit: Electronics Troubleshooting and Repair

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow.* June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate troubleshooting skills**

**Competency Builders:**

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Identify and use proper troubleshooting aids and tools
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits
Explain techniques for identifying thermal failures

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M,S |

**Competency:** **Apply troubleshooting and repair techniques to DC circuits**

**Competency Builders:**
Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Repair faults

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Apply troubleshooting and repair techniques to AC circuits**

**Competency Builders:**

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Repair faults

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Apply troubleshooting and repair techniques in discrete solid-state devices**

**Competency Builders:**

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Repair faults

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | M,S |

**Competency:** **Apply troubleshooting and repair techniques to analog circuits**

**Competency Builders:**
Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S |

**Competency:** **Apply troubleshooting and repair techniques to digital circuits**

**Competency Builders:**
Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-logic circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Apply troubleshooting and repair techniques to a microcomputer system**

**Competency Builders:**
Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Apply troubleshooting and repair techniques to manufacturing systems**

**Competency Builders:**

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

## Unit: Electronics Troubleshooting and Repair for IM

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards developed by the Electronic Industries Association and the Electronics Industries Foundation. Source: *Raising the Standard: Electronics Technician Skills for Today and Tomorrow.* June 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Demonstrate troubleshooting skills**

**Competency Builders:**

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Identify and use proper troubleshooting aids and tools
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Apply troubleshooting and repair techniques to manufacturing systems**

**Competency Builders:**
Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

## Unit: Electronic Product Servicing Technology

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate proficiency in surface mounted devices**

**Competency Builders:**

Describe the principles and operation of types of surface mounted devices (SMDs)
for DC, AC, and solid-state circuits

Describe the proper procedure for handling static sensitive devices (ESD
prevention)

Locate defective SMDs using appropriate troubleshooting techniques

Replace SMDs using appropriate troubleshooting techniques

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate proficiency in radio and television receiving systems**

**Competency Builders:**

Interpret radio and television receiving system block diagrams
Describe the principles and operation of a superhetrodyne receiver
Construct a superhetrodyne receiver
Align a superhetrodyne receiver
Troubleshoot a superhetrodyne receiver
Repair a superhetrodyne receiver
Describe the principles of video signal generation
Describe the principles and operation of TV circuits
Troubleshoot TV circuits
Repair TV circuits
Perform operating systems check to radio and television receiving systems
Adjust radio and television systems
Describe High Definition Television systems
Operate video analyzers
Operate National Television Signal Codes (NTSC) generators
Operate cathode ray tube (CRT) analyzers
Operate stereo generators

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate proficiency in video recording and playback systems**

**Competency Builders:**

Describe characteristics associated with recording and playback systems
Interpret video recording system block and circuit diagrams
Identify operational status of video recording systems (mechanical and electronic)
Perform operating systems check to video recording systems
Adjust video recording systems
Describe the operating characteristics and application of BETA, VHS and 8mm test equipment
Demonstrate the operating characteristics and application of BETA, VHS and 8mm test equipment
Operate vectorscopes and wave form monitors
Describe the operating characteristics and application of BETA, VHS and 8mm recorders and playback systems
Describe the operating characteristics and application of camcorders
Demonstrate the operating characteristics and application of camcorders
Troubleshoot video recording systems
Repair video recording systems
Describe electronic chemicals (e.g., solvents, lubricants, anticorrosives)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate proficiency in laser disc systems**

**Competency Builders:**
Describe characteristics associated with laser disc systems
Interpret laser disc system blocks and circuit diagrams
Describe the operation of laser disc systems
Demonstrate the operation of laser disc systems
Describe the principles and operation of interactive video
Troubleshoot laser disc systems
Repair laser disc systems

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate proficiency in home electronics systems**

**Competency Builders:**

Describe characteristics associated with home automation systems (e.g., computers and peripherals)
Interpret home automation systems block and circuit diagrams
Describe the operation of home automation systems
Replace home automation systems
Describe the principles and operation of fax machines
Demonstrate the operation of fax machines
Describe characteristics associated with electronic security systems
Describe the installation of an electronic security systems
Demonstrate the operation of electronic security systems
Troubleshoot home electronics systems
Repair home electronics systems (e.g., replace and align electronic components)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate proficiency in audio systems**

**Competency Builders:**

Describe the principles and operation of audio systems
Interpret audio systems block and circuit diagrams
Demonstrate the operation of audio systems
Describe the principles and operation of digital audio tape (DAT)
Describe the principles and operation of digital compact cassette (DCC)
Troubleshoot audio systems
Repair audio systems (e.g., replace audio components)

**BIL:** Recommended

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | R |  |

**Competency:** **Demonstrate proficiency in antenna systems (CATV/SATV)**

**Competency Builders:**

Describe the principles and operation of antennae systems
Demonstrate the installation of antenna systems
Describe the principles and operation of a CATV system
Demonstrate the operation of a CATV system
Describe the principles and operation of a SATV system
Demonstrate the operation of a SATV system
Troubleshoot antenna systems
Repair antenna systems (e.g., replace and align antenna components)

## Unit: Programmable Logic Controllers (PLCs)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M |

**Competency:** **Differentiate among instrumentation and control**

**Competency Builders:**

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M |

**Competency:** **Explain basic operation of PLCs**

**Competency Builders:**
Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M,S |

**Competency:** **Demonstrate use of PLCs**

**Competency Builders:**
Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of Graphic Programmable Panel (GPP)
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,M |

**Competency:** **Apply robot fundamentals**

**Competency Builders:**

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

# Unit: Communications Electronics Technology for ET

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | R | C,M,S |

**Competency:** **Describe transmission line applications**

**Competency Builders:**

Explain power conversion
Describe principles and operation of two wire and four wire transmission lines
Describe principles and operation of coaxial cable
Describe principles and operation of microwave guide
Describe principles and operation of fiber optics

**BIL:** Recommended

| EDU: | 12 | AD | AC |
|---|---|---|---|
| | I | R | |

**Competency:** **Demonstrate proficiency in transmitters and receivers**

**Competency Builders:**

Explain the purpose of Federal Communication Commission (FCC) rules and regulations

Describe principles and operation of RF amplifiers

Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, DSSC, Pulse Modulation)

Construct modulators/demodulators

Operate modulators/demodulators

Describe principles and operation of microwave and satellite communication systems

Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | R | |

**Competency:** **Describe various types of multiplexing systems**

**Competency Builders:**

Describe principles and operation of analog multiplexing systems (e.g., CATV)
Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Troubleshoot transmitters and receivers**

**Competency Builders:**
Isolate system faults in CRT modulation/demodulation circuits
Isolate system faults in RF transmitters and receivers
Isolate system faults in RF modulation/demodulation circuits

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate basic proficiency in data communications**

**Competency Builders:**

Describe principles and operation of data communications, signaling systems, codes, formats and protocols
Describe principles and operation of parallel and serial ports
Describe principles and operation of synchronous and asynchronous signals
Describe principles and operation of data modems
Operate data modems
Describe principles and operation of fax machines
Describe principles and operation of various types of networks (e.g., ethernet, token ring)
Demonstrate operation of various types of networks
Describe and demonstrate proper techniques for cable termination (e.g., UTP, COAX, FIBER)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Troubleshoot data communications**

**Competency Builders:**

Isolate system faults in data modems
Isolate system faults in various types of networks
Isolate system faults in various types of cable
Isolate system faults in various types of carrier systems

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate basic proficiency in fiber optic communications systems**

**Competency Builders:**

Describe and demonstrate proper techniques for fiber splicing
Demonstrate techniques for fiber termination
Describe basic characteristics of optics such as reflection, total reflection, and refraction
Describe characteristics and components of fiber optic cables
Describe band width and attenuation limitations for fiber optic systems
Describe technique of wavelength multiplexing in fiber optic cables
Describe characteristics of various types of light sources and light detectors used in fiber optic systems
Describe components of fiber optic transmission systems
Describe transformation of data signals into light pulses
Operate a simple fiber optic data transmission system
Describe proper techniques of fiber termination
Describe characteristics of multi mode and single mode systems

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate proficiency in RF systems safety**

**Competency Builders:**

Demonstrate safety procedures for working with RF systems antennae and support structures (e.g., towers)

Demonstrate safety procedures for working with RF systems high voltage/power supply

Demonstrate safety procedures for working with RF generators

Demonstrate safety procedures for working in RF radiating environments

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate basic proficiency in antenna systems**

**Competency Builders:**

Describe the principles and operation of single element antennae (e.g., 1/4 wave dipole, longwire, vertical)

Describe the principles and operation of multi-element antennae (e.g., point-to-point, broadcast)

Describe the principles and operation of impedance matching of antennae systems

Describe antennae systems measurement

## Unit: Communications Electronics Technology for EM

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | | | |

**Competency:** **Describe transmission line applications**

**Competency Builders:**
Explain power conversion
Describe principles and operation of two wire and four wire transmission lines
Describe principles and operation of coaxial cable
Describe principles and operation of microwave guide
Describe principles and operation of fiber optics

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Demonstrate proficiency in transmitters and receivers**

**Competency Builders:**

Explain the purpose of Federal Communication Commission (FCC) rules and regulations
Describe principles and operation of RF amplifiers
Describe principles and operation of modulation/demodulation (e.g., AM, FM, SSB, DSSC, pulse modulation)
Construct modulation/demodulation device
Operate modulation/demodulation device
Describe principles and operation of microwave and satellite communication systems
Describe principles and operation of repeater systems (e.g., trunk and fiber/scramble/data)
Describe principles of spread spectrum communications
Describe RS232/RS485 Bus

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Describe various types of multiplexing systems**

**Competency Builders:**

Describe principles and operation of analog multiplexing systems (e.g., CATV)
Describe principles and operation of digital multiplexing systems (e.g., T-1, fiber)
Describe principles and operation of CRT modulation

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Troubleshoot transmitters and receivers**

**Competency Builders:**
Isolate system faults in RF amplifiers
Isolate system faults in CRT modulation/demodulation circuits
Isolate system faults in RF transmitters and receivers
Isolate system faults in RF modulation/demodulation circuits

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Demonstrate basic proficiency in data communications**

**Competency Builders:**

Describe principles and operation of data communications, signaling systems, codes, formats and protocols
Describe principles and operation of parallel and serial ports
Describe principles and operation of synchronous and asynchronous signals
Describe principles and operation of data modems
Operate data modems
Describe principles and operation of fax machines
Describe principles and operation of types of carrier systems
Describe principles and operation of various types of networks (e.g., ethernet, token ring)
Demonstrate operation of various types of networks
Describe proper techniques for cable termination (e.g., UTP, COAX, FIBER)
Demonstrate proper techniques for cable termination

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Troubleshoot data communications**

**Competency Builders:**

Isolate system faults in data modems
Isolate system faults in various types of networks
Isolate system faults in various types of cable
Isolate system faults in various types of carrier systems

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Demonstrate basic proficiency in fiber optic communications systems**

**Competency Builders:**

Describe proper techniques for fiber splicing
Demonstrate proper techniques for fiber splicing
Demonstrate techniques for fiber termination
Describe basic characteristics of optics such as reflection, total reflection, and refraction
Describe characteristics and components of fiber optic cables
Describe band width and attenuation limitations for fiber optic systems
Describe technique of wavelength multiplexing in fiber optic cables
Describe characteristics of various types of light sources and light detectors used in fiber optic systems
Describe components of fiber optic transmission systems
Describe transformation of data signals into light pulses
Operate a simple fiber optic data transmission system
Describe proper techniques of fiber termination
Describe characteristics of multi mode and single mode systems

## Unit: Industrial Electricity

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | P | R | S,M,C |

**Competency:** **Explain basic industrial electricity theory**

**Competency Builders:**

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Use the National Electrical Code (NEC), International and OSHA Codes**

**Competency Builders:**
Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures
Identify and use European Economic Commission (EEC) codes
Use lock-out, tag-out procedures
Identify hazardous areas

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S |

**Competency:** **Explain operation of electrical distribution systems**

**Competency Builders:**

Follow NEC, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | P | R | S |

**Competency:** **Maintain basic electrical systems**

**Competency Builders:**
Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | S |

**Competency:** **Interpret electrical/electronic drawings**

**Competency Builders:**
Interpret basic electric/electronic standards and symbols (e.g., IEC, IEEE)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production drawings and assembly drawings

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,M,S |

**Competency:** **Demonstrate proficiency in direct current (DC) circuits**

**Competency Builders:**

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchhoff's laws
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Apply Thevenin's and Norton's theorems

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C,S,M |

**Competency:** **Demonstrate proficiency in alternating current (AC) circuits**

**Competency Builders:**

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter, and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation

Describe basic generator theory and operation

Operate power supplies for AC circuits

Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)

Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters)

Apply maximum power transfer theorems

Apply Thevenin's and Norton's theorems to analyze AC networks

Identify harmonics problems

Correct harmonics problems

# Unit: Wiring Methods

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Apply National Electrical Code (NEC) and National Fire Protection Act (NFPA) regulations**

**Competency Builders:**

Use NEC and NFPA to identify correct materials
Use NEC and NFPA to identify correct methods
Use NEC and NFPA to identify correct applications
Use NEC and NFPA to identify correct safety procedures

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Explain circuit protectors**

**Competency Builders:**
Explain grounding/bonding methods
Explain ground-fault circuit interrupters
Explain overcurrent/short circuit protection
Explain thermal protective devices
Explain difference between ground-fault interrupter and ground-fault protection

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Install wiring**

**Competency Builders:**

Describe functions of permits and licensing requirements
Interpret prints
Verify on-site dimensions
Install electrical boxes and panels
Describe overhead and underground service
Calculate load size conductors
Identify proper color coding
Lay out conduit runs
Install rigid conduit
Install nonmetallic rigid conduit
Install cable trays
Install flexible conduit
Install liquid-tight flexible conduit
Pull conductors
Install ground bonding systems
Install various wire connectors
Inspect rough installation
Prepare for agency inspection
Install bus-duct(s), bus-plug(s), and bus-drop(s)
Install EMT

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Finish wiring**

**Competency Builders:**
Install plugs and switches
Test plugs and switches
Install fixtures
Test fixtures
Install overcurrent protection
Test overcurrent protection
Install ground-fault interrupters (GFI)
Test ground-fault interrupters (GFI)
Install circuit breakers
Test circuit breakers
Label circuit breakers
Update prints and schematics

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Prepare for electrical/ electromechanical equipment installation**

**Competency Builders:**

Identify electrical requirements for equipment
Interpret NEC, NFPA, IEC, and state and local electrical codes
Identify a power distribution source/requirements
Interpret symbols
Interpret schematics/drawings
Prepare site

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Install electrical/electromechanical equipment**

**Competency Builders:**

Build control panel
Install electrical motor control systems
Install electrical motors
Install sensors and various input devices
Install energy-management systems (e.g., lighting, HVAC, load-shedding)
Test equipment and circuits
Connect power to equipment
Test power to equipment

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Interpret schematics and diagrams**

**Competency Builders:**
Identify circuit function
Interpret electrical symbols
Interpret block and ladder diagrams
Interpret schematics

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Trace circuits to locate problems**

**Competency Builders:**
Identify circuit type or subsystem
Locate specific circuits
Apply proper troubleshooting technique(s)
Analyze AC signals using VOM, oscilloscope, or tick tracer

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Maintain electrical systems**

**Competency Builders:**
Diagnose failure
Explain root cause of failure
Review schematic or ladder diagram
Repair or replace defective electrical apparatus
Document corrective action needed or taken

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | |

**Competency:** **Use soldering tools**

**Competency Builders:**

Select appropriate soldering tools and supplies for job

Perform soldering and desoldering techniques (e.g., micro-miniature, standard)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Install Class II systems**

**Competency Builders:**
Define Class II systems
Comply with local, state, and federal codes (e.g., NEC, NFPA)
Install communication system
Install control system
Install lighting system
Install security systems
Install energy management monitoring systems
Maintain systems
Verify system operation

# Unit: Electrical Test and Measurement Equipment

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Demonstrate proficient use of electrical test equipment**

**Competency Builders:**

Describe function and operation of logic probe and logic analyzer
Describe function and operation of power monitor
Describe function and operation of signal generator
Describe function and operation of spectrum analyzer
Describe function and operation of AC/DC hi-pot
Describe function and operation of time-domain reflectometer (TDR)
Describe function and operation of megger
Describe function and operation of curve tracer/analogger
Apply test equipment to DC circuits
Apply test equipment to AC circuits
Apply test equipment to solid-state devices
Apply test equipment to digital circuits
Apply test equipment to analog circuits
Apply test equipment to microprocessors

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,S,M |

**Competency:** **Demonstrate proficient use of electrical measurement equipment**

**Competency Builders:**
Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of clamp-on amp meter
Describe function and operation of oscilloscopes
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors

# Unit: Electronic Assembly and Repair

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | |

**Competency:** **Perform basic soldering of electrical components**

**Competency Builders:**

Prepare surfaces to be soldered
Select appropriate solder
Select appropriate flux
Select appropriate soldering iron temperature
Select appropriate soldering iron tip shape
Select appropriate flux remover
Select appropriate surface sealant
Inspect solder joints under microscope
Identify good and bad solder joints – SMT and PTH
Measure solder joint resistance of good and bad joints
Demonstrate solder techniques for SMD components
Demonstrate techniques for soldering to terminals

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Perform basic repair of electronic boards**

**Competency Builders:**

Demonstrate removal of SMD
Demonstrate removal of PTH components
Demonstrate PCB track repair
Demonstrate use of solder removal tools

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Operate wave soldering machine**

**Competency Builders:**
Inspect surfaces to be soldered
Select appropriate solder
Select appropriate flux
Set all machine parameters (e.g., temperature, wave amplitude, transport velocity)
Inspect solder joints of completed printed circuit boards

## Unit: Equipment Installation

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Explain installation procedures**

**Competency Builders:**

Explain relocation procedures for new equipment in an existing facility
Explain the use of anchors and isolators
Explain procedures for moving and installing new equipment
Explain leveling and aligning procedures
Explain test run guidelines
Explain safety precautions for equipment installation procedures
Explain grounding procedures
Explain installation of utilities (e.g., electricity, air, water, drains)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Prepare for equipment installation**

**Competency Builders:**

Identify equipment requirements (including safety)
Identify maintenance services needed
Identify method of moving and equipment needed
Identify measuring devices
Calculate weights
Follow manufacturer's specifications and manuals
Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
Read drawings/schematics
Revise drawings if applicable
Interpret prints

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Install Equipment**

**Competency Builders:**
Prepare site
Use measuring devices
Calculate weight
Follow manufacturer's specifications
Use appropriate moving equipment
Align equipment to layout specifications
Apply electrical, mechanical, hydraulic, and/or pneumatic principles

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Explain rigging functions**

**Competency Builders:**
Estimate the weight of a load
Find the center of gravity
Identify the rigging and slings used in maintenance work
Explain safety inspection procedures for rigging, ropes, and slings
Perform safety inspection procedures for rigging, ropes, and slings
Identify rope fiber types
Tie rigging knots, bends, and hitches
Identify types of wire rope
Cut wire rope assemblies and termination's
Identify cranes and hoists
Identify and explain scaffolding types
Identify safety equipment (e.g., safety harness, nets)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C |

**Competency:** **Perform rigging functions**

**Competency Builders:**

Perform safety inspection procedures for rigging, ropes, and slings
Tie rigging knots, bends, and hitches
Cut wire rope
Seize wire rope
Splice wire rope
Erect a scaffold per new OSHA standards
Rig safety harness and nets

## Unit: Equipment Maintenance

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | P | R | C |

**Competency:** **Perform housekeeping**

**Competency Builders:**
Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs, and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,C |

**Competency:** **Perform recordkeeping**

**Competency Builders:**

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Inspect machine systems**

**Competency Builders:**
Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C |

**Competency:** **Perform machine maintenance**

**Competency Builders:**

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance
Review analysis with operator

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M,S |

**Competency:** **Maintain and properly use hand tools**

**Competency Builders:**

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)

Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing

Demonstrate use and care of common hand tools

Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)

Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)

Demonstrate use and care of ropes, slings, pullers, and block and tackle

Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)

Demonstrate use and care of pipe clearing equipment

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Maintain and properly use portable power tools**

**Competency Builders:**
Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad, and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Maintain and properly use stationary equipment**

**Competency Builders:**

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

# Unit: Industrial Engineering Basics

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | |

**Competency:** **Apply knowledge of workstation design**

**Competency Builders:**

Participate in development of overall plant layout
Identify minimal movement of materials and parts throughout production line
Plan operator's access to materials and tools
Eliminate unnecessary body moves (e.g., bends, turns, stoops, hand movements)
Identify physical safety items (e.g., equipment, temperature, fumes, light)
Identify methods to prevent operator from reaching across moving parts
List type of material handling equipment for operation
Calculate bench space needs for process and storage
Calculate machine controls to position operator efficiently
Physically simulate operation
Review total process for simplification

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,M,C |

**Competency:** **Demonstrate knowledge of ergonomics**

**Competency Builders:**
Define ergonomics
Identify risk factors
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Identify need for mats and footrest for standing jobs
Identify need for appropriate working heights of chairs, stools, workbenches, equipment
Identify need for adequate lighting
Explain use of anthropometric design
Explain use of rest pauses
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Apply knowledge of methods engineering**

**Competency Builders:**
Define methods engineering
Define goals of methods engineering (e.g., quality, increase productivity, decrease per unit cost)
Set sequence of production operations
Set sequence of needed inspections
Recommend methods to shorten process time
Recommend alternate operations
Recommend ways to eliminate operations
Ascertain if operations can be performed within facilities
Test machine capability
Follow documentation procedures

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Apply knowledge of standards engineering**

**Competency Builders:**
Estimate times by computer simulation
Use predetermined time system (e.g., MTM family)
Use work sampling
Define reach, grasp, move position, turn, apply pressure, and release
Define standard time
Define performance rating
Define allowances
Identify leveling factors (e.g., skill levels, effort, work area conditions, consistency)
Identify allowance factors (e.g., fatigue, delay, personal)
Calculate production rate
Write job description data
Complete job status reports
Analyze job evaluation data

## Unit: Industrial Manufacturing Technology

The Competencies in this Unit meet or exceed the applicable sections of the National Occupational Skill Standards of the National Coalition for Advanced Manufacturing and the Metalworking Industry Skills Standards Board. Sources: *National Skill Standards for Advanced High Performance Manufacturing. Version 2.1.* April 1997, pp. 36-39 and *Duties and Standards for Machining Skills. Level I. Duty 3.* November 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Describe industrial manufacturing processes**

**Competency Builders:**

Identify safety related items

Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature

Explain mechanical and chemical properties of ferrous and non-ferrous metals

Explain industrial manufacturing process

Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases

Develop flow chart and process sheets

Explain preventive maintenance and calibration procedures

Explain need for manufacturing documentation (e.g., ISO 9000)

Define quality process

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,M |

**Competency:** **Demonstrate knowledge of materials requirements planning (MRP)**

**Competency Builders:**

Define materials requirements planning

Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)

Interpret master production schedule and bill of materials

Explain inventory carrying cost and economic order quantity

Describe the use of the computer in MRP

Calculate net requirements

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Demonstrate knowledge of material supply process (MSP)**

**Competency Builders:**
Describe role of purchase requisitions and/or purchase orders
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | C,M |

**Competency:** **Demonstrate knowledge of plant layouts**

**Competency Builders:**

Describe the importance of flexibility

Differentiate among product layout, process layout, fixed position layout, and cellular layout

Describe the type of production suited to each layout

Describe advantages and disadvantages of each layout

Describe importance of flexibility of material flow

Differentiate straight-line, U-shaped, convoluted, and comb patterns

Describe advantages and disadvantages of each pattern

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate knowledge of quality control process of materials handling**

**Competency Builders:**

Maintain system for physical handling and movement of material in-process and in-storage

Monitor system of physical handling and movement of material in-process and in-storage

Maintain system for physical handling and movement of finished products

Monitor system of physical handling and movement of finished products

Write requests for deviation from specifications

Implement quality control and inspection standards and procedures

Write engineering change notices and rejection reports

Monitor reports of discrepancy or rejects during production process

Conduct quality tests under different environmental conditions

Explain importance of product protection, identification and storage

Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)

Describe manual methods of storage and retrieval

Describe automated storage and retrieval systems (ASRS)

Describe automated guided vehicle moving systems (AGVS)

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | M,C |

**Competency:** **Apply statistical process control techniques**

**Competency Builders:**
Describe (SPC) statistical process control and its applications
Describe a sampling plan
Inspect parts for necessary data
Plot on appropriate control charts
Analyze a manufacturing process
Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

## **Unit:** Basic Materials Science

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | S,M,C |

**Competency:** **Demonstrate basic knowledge of metallurgy**

**Competency Builders:**
Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of heat treatment**

**Competency Builders:**

Describe process of heat treating

Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of metal characteristics and formability**

**Competency Builders:**
Explain metal and formability basics
Explain metal grades and coatings
Explain part contour analysis
Explain tensile test
Explain LDH test
Explain bend test
Explain hold expansion test
Explain R-value test
Explain hardness test
Explain cup test
Explain friction test
Explain surface test
Explain interpretation of metal characteristics tests
Describe blank/die interactions (e.g., friction)
Describe friction and forming process
Describe circle grid basics
Describe circle grid applications
Describe formability diagnostics
Describe the documentation process

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of casting**

**Competency Builders:**
Identify frequently used metals
Describe crystalline structures of metals
Use periodic chart in evaluating metals
List chemical properties of common metals
List physical properties of common metals
Define permanent mold casting
Define shell mold casting
Define sand casting and pattern making
Define die casting
Identify basic casting terms
Identify advantages/disadvantages of casting processes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of iron and its alloys**

**Competency Builders:**
Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of aluminum and its alloys**

**Competency Builders:**

Define aluminum and its alloys
Describe aluminum manufacturing process
Describe the structure of aluminum
List chemical properties of aluminum
List physical properties of aluminum
Describe aluminum property variables
Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)**

**Competency Builders:**
Define copper and its alloys
Describe copper manufacturing process
Describe the structure of copper
List chemical properties of copper
List physical properties of copper
Describe copper property variables
Describe measures of copper strength
Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of plastics and polymers**

**Competency Builders:**

Define thermo-analysis testing (e.g., melt flow, moisture control)
Define plastics and polymers
Describe plastics and polymers manufacturing processes
Describe structure of plastics and polymers
List chemical properties of plastics and polymers
List physical properties of plastics and polymers
Differentiate thermoset and thermoplastic
Describe plastics and polymer property variables
Describe measure of plastic and polymer strength
Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
Perform tensile test
Perform R-value test

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of ceramics**

**Competency Builders:**

List Ingredients of ceramic products

List qualities of ceramic products

Describe quality control tests (e.g., compressive strength test, wear resistance test, temperature resistance test)

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of concrete**

**Competency Builders:**

Describe the formation of concrete

List types of cements and their uses

Define qualities of concrete (e.g., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)

List tests used in concrete production (e.g., slump test, test of fineness modules)

List protective practices used after pouring

Describe concrete tools and applications (e.g., float, chairs)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate knowledge of corrosion and protection**

**Competency Builders:**
Identify causes of corrosion
Identify types of corrosion
List solutions to minimize problems
Identify corrosion testing

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Demonstrate basic knowledge of rubber manufacturing**

**Competency Builders:**

Explain history of rubber industry

Compare properties of natural rubber with those of synthetic rubber

Explain how natural rubber is manufactured

Explain vulcanization, mastication, and cure systems

Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)

Explain press and autoclave curing

Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)

Explain rubber testing (e.g., tensile, durometer)

## Unit: Mechanical Power Transmission

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Demonstrate knowledge of basic mechanics**

**Competency Builders:**

Explain working forces of torque, tension, and compression
Explain the laws of motion
Explain how to calculate work in several ways
Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw, gears
Explain the types of power and the method of producing power
Explain the laws of friction
Explain mechanical efficiency
Apply basic knowledge of physics
Apply basic knowledge of stress, strain, and fatigue
Calculate speed changes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Describe mechanical power transmission systems**

**Competency Builders:**

Describe the principles and operation of compound and reverted gear trains
Describe the principles and operation of internal and planetary gear trains
Describe the principles and operation of helical and bevel gear trains
Describe the principles and operation of rack and pinion, worm and wheel, and block and screw mechanisms
Describe the principles and operation of counter rotating mechanisms and differentials
Describe the principles and operation of spring mechanisms, pulley blocks, and differentials
Describe the principles and operation of chain, belt and disc drives and universal joints
Describe the principles and operation of clutch and coupling mechanisms
Describe the principles and operation of braking mechanisms
Describe the necessity for proper alignment and fit of mechanical devices
Describe the necessity for proper balance of system components
Describe proper component matching (e.g., sheave sets, gear sets)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Use bearings**

**Competency Builders:**

Define bearing
Identify types of bearings and their applications
Identify installation method
Install bearings
Maintain bearings (e.g., lubrication)
Remove bearings
Identify bearing failure modes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Use seals**

**Competency Builders:**
Define seal
Identify types of seals and their applications
Identify installation method
Install seals
Maintain seals
Remove seals
Identify failure modes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S |

**Competency:** **Use gears**

**Competency Builders:**

Define gears
Identify types of gears, their materials, and their applications
Identify installation method
Install gears
Maintain gears (e.g., lubrication)
Remove gears
Identify failure modes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Use sheaves**

**Competency Builders:**
Define sheaves
Identify types, tolerances, and materials of sheaves and their applications
Identify installation method
Install sheaves
Maintain sheaves
Remove sheaves
Identify failure modes

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | M,S |

**Competency:** **Use belts and pulleys**

**Competency Builders:**
Define belts and pulleys
Identify types of belts and pulleys and their applications
Identify installation method
Install belts and pulleys
Maintain belts and pulleys
Remove belts and pulleys
Identify failure modes

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | M,S |

**Competency:** **Use sprockets and chains**

**Competency Builders:**
Define sprockets and chains
Identify types of sprockets and chains and their applications
Identify installation method
Install sprockets and chains
Maintain sprockets and chains
Remove sprockets and chains
Identify failure modes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Use cams and levers**

**Competency Builders:**
Define cams and levers
Identify types of cams and levers and their applications
Identify installation method
Install cams and levers
Maintain cams and levers
Remove cams and levers
Identify failure modes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Use clutches and brakes**

**Competency Builders:**

Define clutches and brakes
Identify types of clutches and brakes and their applications
Identify installation
Install clutches and brakes
Maintain clutches and brakes
Remove clutches and brakes
Identify failure modes

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Install drive components**

**Competency Builders:**
Identify types of couplings and their applications
Install solid coupling
Install jaw coupling
Install molded rubber coupling
Install chain type coupling
Install a clutch
Install brakes
Align bearings, bushing, and cams
Install V-belts and adjust tensions
Install a V-belt and manually adjustable sheaves
Adjust a V-belt and manually adjustable sheaves
Install a V-belt with spring loaded adjustable sheaves
Explain the purposes and advantages of a chain drive system
Explain the function of speed reducers
Explain the function of gears and variable speed reducers
Install shafts
Align shafts
Mount drive sprockets and chains
Mount sheaves and pulleys
Mount gears on open gear drives
Align gears on open gear drives
Install a mechanical clutch system
Install adjustable speed drives
Troubleshoot adjustable speed drives
Explain the operation of fluid couplings
Install fluid couplings
Install torque converters
Perform preventive maintenance on drive components
Inspect completed work

Describe types of fit and tolerances
Explain importance of balance

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Describe the operation of mechanisms, linkages and levers**

**Competency Builders:**

Describe class one, two, three, and compound levers

Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms

Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)

Describe the principles and operation of drag link and intermediate mechanisms

Describe the principles and operation of four-bar variations

Describe the principles and operation of cam mechanisms

Describe the principles and operation of pivoted follower mechanisms

Describe the principles and operation of toggle, quick return, and ratchet mechanisms

Describe the principles and operation of geneva mechanisms

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | M,S |

**Competency:** **Apply knowledge of lubricants**

**Competency Builders:**

Explain the function of lubricants
Explain the properties of oil lubricants and factors determining the selection of lubricants
Identify types and functions of lubricant additives
Describe types of circulating oils and their purposes
Describe lubricating systems, including the charts and methods used
Demonstrate proper grease application
Demonstrate proper lubricant storage and handling
Lubricate a piece of industrial equipment
Identify specified lubricant or equivalent
Explain lubricant recovery and disposal
Explain use of oil analysis reports

# Unit: Fundamentals of Machine Anatomy

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C,M |

**Competency:** **Interpret specifications for a machine**

**Competency Builders:**
Identify power source
Identify power transmission
Identify hydraulic/pneumatic actuators
Identify materials
Identify fits/tolerances
Identify geometric dimension and tolerancing (GD&T) symbols
Identify safety factors
Participate in concurrent engineering
Demonstrate knowledge of print reading

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Build a machine to specifications**

**Competency Builders:**
Install hydraulic and pneumatic actuators
Troubleshoot hydraulic and pneumatic actuators
Install motors
Troubleshoot motors
Install sensors
Troubleshoot sensors
Install PLC's
Troubleshoot PLC's
Install industrial controls
Troubleshoot industrial controls
Install power distribution systems
Troubleshoot power distribution systems
Install brakes and clutches
Troubleshoot brakes and clutches
Install lubrication system
Troubleshoot lubrication system

## Unit: Electromechanical Technology

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Interpret electromechanical drawings**

**Competency Builders:**
Identify types of drawings and their applications
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Describe the operation of electronic sensors and transducers**

**Competency Builders:**
Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation
Explain pressure transducers operation

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C,M,S |

**Competency:** **Demonstrate knowledge of transducers (sensors) and instrumentation**

**Competency Builders:**

Describe characteristics associated with transducers and instrumentation

Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Troubleshoot transducers

Differentiate among thermocouple types

Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)

Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits

Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)

Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT))

Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)

Interpret specifications of final control elements (e.g., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)

Describe application circuits

Calculate specification of proximity sensors

Calculate specifications of infrared and photo-sensors

Explain use of proximity sensors

Explain use of photo electric sensors

Explain use of mechanically activated switches

Troubleshoot switch failure

Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C,M,S |

**Competency:** **Demonstrate knowledge of power distribution systems**

**Competency Builders:**
Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Demonstrate lock-out/tab-out procedures
Describe inner lock systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Demonstrate proficiency in power distribution equipment**

**Competency Builders:**
Describe power transformers
Interpret transformer name plate data
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe current transformer safety procedures
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Demonstrate lock-out/tag-out procedures
Describe inner lock systems
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot voltage transformers
Troubleshoot medium-voltage circuit breakers and fuses

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | M,S,C |

**Competency:** **Demonstrate knowledge of motors and motor control**

**Competency Builders:**

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe common start/stop circuits
Describe operation of common AC motors
Explain motor starters/overloads
Explain motor's EFF
Explain power factor affect on motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops
Interpret motor name plate data

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Apply quality control techniques**

**Competency Builders:**
Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Apply electromechanical maintenance management practices**

**Competency Builders:**
Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Explain computer management maintenance systems (CMMS)
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

## Unit: Electromechanical Technology for IM

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C |

**Competency:** **Interpret electromechanical drawings**

**Competency Builders:**
Identify types of drawings and their applications
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Describe the operation of electronic sensors and transducers**

**Competency Builders:**

Explain temperature transducers operation
Explain stress and strain pressure transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,M,S |

**Competency:** **Demonstrate proficiency in transducers (sensors) and instrumentation**

**Competency Builders:**

Describe characteristics associated with transducers and instrumentation

Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)

Troubleshoot transducers

Differentiate among thermocouple types

Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)

Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits

Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)

Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT))

Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)

Interpret specifications of final control elements (e.g., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)

Describe application circuits

Calculate specification of proximity sensors

Calculate specifications of infrared and photo-sensors

Explain use of proximity sensors

Explain use of photo electric sensors

Explain use of mechanically activated switches

Troubleshoot switch failure

Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,S,C |

**Competency:** **Demonstrate proficiency in power distribution systems**

**Competency Builders:**

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Demonstrate lock-out/tag-out procedures
Describe kirk key inner lock systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C,S |

**Competency:** **Demonstrate proficiency in power distribution equipment**

**Competency Builders:**
Describe power transformers
Describe transformer name plate data
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe current transformer safety procedures
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Demonstrate lock-out/tag-out procedures
Describe kirk key inner lock systems
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,S,C |

**Competency:** **Demonstrate proficiency in motors and motor control**

**Competency Builders:**
Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Explain power factor effect on motors
Demonstrate two and three wire control concepts
Explain motor starter/overloads
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops
Explain motor name plate data

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,S,C |

**Competency:** **Apply quality control techniques**

**Competency Builders:**
Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,S,C |

**Competency:** **Apply electromechanical maintenance management practices**

**Competency Builders:**

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Explain computer management maintenance systems (CMMS)
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

## Unit: Hydraulics and Pneumatics

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,M,C |

**Competency:** **Describe fluid flow concepts**

**Competency Builders:**

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | S,C |

**Competency:** **Describe energy considerations**

**Competency Builders:**

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C |

**Competency:** **Describe system losses**

**Competency Builders:**
Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | S,C |

**Competency:** **Describe hydrostatics**

**Competency Builders:**
Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | I | P | S,M |

**Competency:** **Calculate energy**

**Competency Builders:**
Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S |

**Competency:** **Design basic hydraulic/pneumatic system**

**Competency Builders:**
Use common symbols
Create circuit diagrams (e.g., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C |

**Competency:** **Describe component operation**

**Competency Builders:**
Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)
Identify and interpret pressure ratings

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | S |

**Competency:** **Interpret hydraulic and pneumatic schematics**

**Competency Builders:**
Identify common symbols
Sketch circuit diagrams (e.g., schematics)
Interpret circuit diagrams (e.g., schematics)
Analyze circuit
Diagram an air supply system

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S |

**Competency:** **Troubleshoot hydraulic and pneumatic circuits**

**Competency Builders:**
Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C |

**Competency:** **Perform pump maintenance and repair**

**Competency Builders:**

Identify types and operating features of pumps

Identify pump capacity and system requirements

Explain packing and seal requirements

Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)

Perform pump maintenance

Disassemble a pump

Reassemble a pump

Test pump

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C |

**Competency:** **Maintain piping and accessories for high and low pressure fluid power systems**

**Competency Builders:**

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,C,S |

**Competency:** **Maintain hydraulic system components**

**Competency Builders:**
Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S |

**Competency:** **Troubleshoot hydraulic systems**

**Competency Builders:**
Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C |

**Competency:** **Describe reciprocating and rotary air compressors**

**Competency Builders:**
Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S |

**Competency:** **Maintain pneumatic systems**

**Competency Builders:**
Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves
Safety precautions

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S |

**Competency:** **Troubleshoot pneumatic systems**

**Competency Builders:**
Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S |

**Competency:** **Maintain vacuum systems**

**Competency Builders:**

Describe characteristics associated with vacuum systems and sub-atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

## **Unit:** Hydraulics and Pneumatics for ET

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,M |

**Competency:** **Describe fluid flow concepts**

**Competency Builders:**

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,M |

**Competency:** **Describe energy considerations**

**Competency Builders:**
Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,M |

**Competency:** **Describe component operation**

**Competency Builders:**

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,S |

**Competency:** **Interpret hydraulic and pneumatic schematics**

**Competency Builders:**
Identify common symbols
Sketch circuit diagrams (e.g., schematics)
Interpret circuit diagrams (e.g., schematics)
Sketch circuit analysis
Diagram an air supply system

## Unit: Computerized Numerical Control (CNC) for EM

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill Standards developed by the Metalworking Industry Skills Standards Board. Source: *Duties and Standards for Machining Skills. Level II. Duties 2.22 and 2.23.* January 1995.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Demonstrate knowledge of CNC**

**Competency Builders:**

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Define canned cycles
Differentiate hardware and software
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | P | |

**Competency:** **Perform preventive maintenance**

**Competency Builders:**
Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Identify wear and alignment issues on CNC equipment

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | | | |

**Competency:** **Prepare CNC program**

**Competency Builders:**
Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using a CAD/CAM package
Program machine using manual data input (MDI) process

## **Unit: Computerized Numerical Control (CNC) for IM**

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill Standards developed by the Metalworking Industry Skills Standards Board. Source: *Duties and Standards for Machining Skills. Level II. Duties 2.22 and 2.23.* January 1995.

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | C |

**Competency:** **Demonstrate knowledge of CNC**

**Competency Builders:**
Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Explain the purpose of the post-processor
Define canned cycles
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Perform preventive maintenance**

**Competency Builders:**
Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment
Identify wear and alignment issues on CNC equipment

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C |

**Competency:** **Apply CNC operations**

**Competency Builders:**
Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development
Apply proper set-up procedures

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | |

**Competency:** **Prepare CNC program**

**Competency Builders:**
Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using a CAD/CAM package
Program machine using manual data input (MDI) process

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | M |

**Competency:** **Program CNC operations**

**Competency Builders:**
Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates, and surface feet per minute limitations
Turn intersection points into segments (e.g., defined in terms of points, lines, and circles)
Debug program

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Load machine**

**Competency Builders:**
Load program from MDI and/or off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M |

**Competency:** **Operate CNC machine**

**Competency Builders:**
Perform dry run
Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Inspect part
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

## Unit: Precision Machining

The Competencies in this Unit meet or exceed the applicable technical sections of the National Occupational Skill developed by the Metalworking Industry Skills Standards Board. Source: *Duties and Standards for Machining Skills. Level I. Duties 1 and 2.* November 1994.

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | C,M |

**Competency:** **Perform prerequisite machining skills**

**Competency Builders:**

Demonstrate maintenance of immediate work area, machinery, tools and gages
Demonstrate proficiency in interpreting prints/drawings
Demonstrate proficiency in planning work sequence/set up
Follow safety rules and regulations for each machine
Identify and use personal protective equipment for each machine

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,C |

**Competency:** **Analyze machine shop jobs**

**Competency Builders:**

Identify sequence of work on specified project(s)
Identify tolerances and finishes on specified project(s)
Identify variables that effect job efficiency (e.g., speeds, feeds)
Use machinery handbook
Identify causes of workpiece defects

**BIL:** Essential

|  |  |  |  |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
|  | P | R | M,C |

**Competency:** **Achieve machine shop job standards**

**Competency Builders:**
Write machine shop job procedure
Complete machine shop job status report(s)
Analyze machine shop job evaluation data

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,S |

**Competency:** **Perform bench operations**

**Competency Builders:**
Use measuring instruments and hand tools
Deburr workpiece
Lay out workpiece
Drill hole
Hand tap hole
Cut threads with die
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,S,C |

**Competency:** **Operate metal cutting saw**

**Competency Builders:**
Identify types and uses
Transfer dimensions from blueprint
Clean metal cutting saw
Lubricate metal cutting saw
Install guides
Adjust guides
Select proper blades
Weld saw blade
Install saw blade
Select speeds and feeds
Cut metal
Deburr workpiece
Apply basic metallurgy knowledge
Identify proper cutting fluids

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | P | R | M,S,C |

**Competency:** **Operate drill press**

**Competency Builders:**
Clean drill press
Lubricate drill press
Identify proper cutting fluid
Mount part in holding device/fixture
Select proper bit, speed, and feed
Demonstrate proper bit sharpening techniques
Drill part
Countersink
Tap hole
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Operate tool and cutter grinding machine**

**Competency Builders:**
Identify parts of machine
Identify proper cutting fluids
Identify causes of workpiece defects
Select proper wheels and work holding devices (e.g., superabrasives)
Perform truing operations
Perform dressing operations
Perform forming operations
Select proper speeds and feeds
Sharpen end mill
Sharpen horizontal milling cutter
Sharpen drills and countersinks
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Operate pedestal grinder**

**Competency Builders:**
Clean pedestal grinder
Lubricate pedestal grinder
Identify proper wheel
Identify proper coolant
Check wheel for defects
Mount wheel
Position guard and rest
Dress wheel
Sharpen drill bit
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Operate lathe**

**Competency Builders:**
Clean and lubricate lathe
Deburr
Demonstrate use of a 4-jaw chuck
Identify proper cutting fluid
Identify proper tools and holders
Sharpen tools properly
Mount workpiece
Use dial indicator
Position guards
Select feed(s) and speed(s)
Face workpiece
Turn shaft
Turn taper
Knurl workpiece
Cut off workpiece
Center drill hole
Cut threads (inside and outside)
Turn inside bore
Demonstrate use of steady rest
Demonstrate use of centers
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S,C |

**Competency:** **Operate milling machine**

**Competency Builders:**
Clean milling machine
Lubricate milling machine
Identify proper cutting fluid
Select proper tool
Select proper feeds and speeds
Type of cut (e.g., climb, std.)
Mount workpiece
Mount tool
Mill surface
Mill keyway
Drill workpiece
Bore with milling machine
Mill angle
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Operate surface grinder**

**Competency Builders:**
Clean surface grinder
Lubricate surface grinder
Identify proper cutting fluid
Select proper wheel
Select proper speeds and feeds
Check wheel for defects
Mount wheel
Position guard
Dress wheel
Identify proper mounting techniques
Mount workpiece
Set surface grinder
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,C,M |

**Competency:** **Select materials**

**Competency Builders:**

Interpret color codes, numbering systems, and classification systems of materials (e.g., ANSI, SAE)
Identify metals using spark test
Identify metals using variety of tests
Identify materials
Apply basic metallurgy knowledge

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,M |

**Competency:** **Perform heat treatment and testing of metals**

**Competency Builders:**
Test hardness of metals
Perform non-destructive testing
Perform destructive testing
Harden metals to job specifications
Temper metals to job specifications
Anneal metals to job specifications
Normalize metals to job specifications
Case harden metals to job specifications

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | C,S,M |

**Competency:** **Explain nontraditional machining processes**

**Competency Builders:**

Describe principles of chemical etching
List applications of chemical etching
List advantages/disadvantages of chemical etching
Describe principles of photochemical etching
List applications of photochemical etching
List advantages/disadvantages of photochemical etching
Describe electrical-discharge machining (EDM)
List applications of Plunge EDM
Differentiate between Plunge EDM and wire EDM
List applications for wire EDM
Describe principles of electrochemical machining
List applications of electrochemical machining
List advantages/disadvantages of electrochemical machining
Describe principles of water jet cutting
List applications of water jet cutting
Describe principles of torch cutting
List applications of torch cutting
Describe principles of laser cutting
List applications of laser cutting
List advantages/disadvantages of laser cutting
Describe shot peen
Describe media finish
Describe glass bead
Describe principles of laser welding

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | S,M,C |

**Competency:** **Perform precision layouts**

**Competency Builders:**
Identify appropriate tools for measuring
Describe precision, accuracy, tolerance, reliability, and discrimination
Distinguish between precision and semiprecision measuring
Define standard stock dimensions and tolerances
Demonstrate knowledge of different units of measure (metric, standard, inches)
Describe common measurement errors and correction procedures
Calibrate measuring machines and devices
Demonstrate care of measuring instruments
Demonstrate use of rule
Demonstrate use of tape
Demonstrate use of pi tape
Demonstrate use of combination square
Demonstrate use of calipers
Demonstrate use of micrometers (inside and out)
Demonstrate use of dial indicators
Demonstrate use of sine bar
Demonstrate use of gauges (e.g., dial bore, dial snaps)
Demonstrate use of surface plate
Demonstrate use of protractor
Explain use of profilometer
Demonstrate use of thermometer
Demonstrate use of dividers
Demonstrate basic use of gauge blocks
Demonstrate use of threading specs
Explain use of optical comparitor
Explain use of digital instruments
Explain use of electronic gauging equipment
Explain use of data acquisition equipment

Explain operation of manual coordinate measuring machine (CMM)
Explain use and application of laser alignment/measurement

## Unit: Metal Stamping Dies

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Describe different types of dies**

**Competency Builders:**
Describe crimping die
Describe parts assembly die
Describe CAM bending die
Describe blanking die
Describe pierce die
Describe forming die
Describe draw die
Describe progressive die

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Describe fixtures**

**Competency Builders:**
Describe crimping fixture
Describe locating fixture
Describe press fitting fixture
Describe riveting fixture
Describe welding fixture

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,S,C |

**Competency:** **Design product**

**Competency Builders:**
Draw isometric view of product
Construct model (e.g., clay, form, wood, plastic)
Scan model
Wire frame data
Create computerized model
Interface model with CAD/CAM
Reproduce surface finish
Identify materials for product
Create prototype
Validate product
Standardize product

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,M,C |

**Competency:** **Troubleshoot design errors**

**Competency Builders:**
Isolate cause of die component breakage
Isolate cause of failure of parts to be removed from die
Isolate cause of incorrect punch clearance
Isolate cause of incorrect die clearance
Isolate cause of misfitting die components

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C |

**Competency:** **Correct design errors**

**Competency Builders:**

Correct cause of die component breakage
Correct cause of failure of parts to be removed from die
Correct cause of improper punch clearance
Correct cause of improper die clearance
Correct cause of misfitting die components

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,M,S |

**Competency:** **Explain die processing**

**Competency Builders:**
Describe preplanning activities
Describe die layout
Identify die operations (e.g., number, purpose and sequence of die operations)
Describe feasibility study development
Describe sequence of operations from die construction

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,M,S |

**Competency:** **Explain pattern shop applications**

**Competency Builders:**

Describe pattern shop activities
Describe die pattern materials (e.g., wood, styrofoam, ceramic)
Describe die pattern construction
Describe casting of dies
Describe casting of components
Describe model process steps
Describe model use

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,S,C |

**Competency:** **Explain die construction (e.g., production and operation techniques)**

**Competency Builders:**
Explain need for basic machining skills
Explain need for sculptured machining skills
Explain EDM functions
Explain die material standards
Describe tool and die welding
Describe punch finishing
Explain lifter/gauging systems
Explain pressure systems
Describe function of cams

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C |

**Competency:** **Explain the die tryout process**

**Competency Builders:**
Explain need to use analytical problem solving for die tryout
Describe process documentation
Describe die modification techniques
Describe blank modification techniques
Describe die buy-off
Describe die release
Describe part release
Describe die coatings
Describe die treatments

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Explain die maintenance**

**Competency Builders:**
Describe planned die maintenance
Describe predictive die maintenance
Describe preventive die maintenance
Describe die maintenance troubleshooting techniques
Describe die refurbishment techniques

# Unit: Press Technology

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Explain press operation**

**Competency Builders:**

Identify types of presses
Describe functions of presses
Identify capacity of presses
Identify operator safety devices

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Demonstrate knowledge of press accessories**

**Competency Builders:**
Describe function of monitors, proximity switches and die protection
Describe function of loaders
Describe function of roller levelers
Describe function of decoilers
Describe function of feeders
Describe function of transfer mechanisms
Describe function of lubricators and coolants
Describe processing of coil steel
Describe use of SMED change
Describe press set-up

## Unit: Sheet Metal Fabrication

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M,C,S |

**Competency:** **Demonstrate knowledge of sheet metal fabrication**

**Competency Builders:**

Describe sheet metal fabricated products
Describe press working process
Describe process(es) of straightening metal
Describe metal finishing and coating
Explain bend allowances
Identify materials used for sheet metal fabrication (e.g., hot roll, cold roll, aluminum, stainless)
Explain process of determining metal thicknesses
Explain process of layout
Explain process of fastening
Explain process of punch and die clearance and alignment
Demonstrate the capability to finish (cleaning, painting, plating)
Demonstrate CADD uses for layout

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,M |

**Competency:** **Describe types of metal fabrication manufacturing**

**Competency Builders:**
Describe shear
Describe press brake
Describe cut-to-length lines
Describe roll forming
Describe computer numerical control (CNC) turret presses
Describe flexible manufacturing system (FMS) cells

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Layout sheet metal**

**Competency Builders:**

Lay out 90° ells
Lay out 95° and 30° ells
Use radial line development to lay out
Use development by triangulation to lay out

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Fabricate components**

**Competency Builders:**

Layout design
Measure materials
Create pattern and/or prototype
Use hand tools
Cut materials
Form materials
Use temporary and permanent fasteners

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | M |

**Competency:** **Perform sheet metal fabrication**

**Competency Builders:**
Identify sheet metal fabrication jobs
Identify tools needed (e.g., manual and hand powered)
Fabricate round ells
Fabricate tees
Fabricate pyramids
Fabricate cones
Fabricate transitions

## Unit: Basic Moldmaking

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C |

**Competency:** **Explain processes for building molds**

**Competency Builders:**
Describe process of making a mold
Describe machinery used in moldmaking
Describe types of metal used for molds
Identify types of components used in the forming process (e.g., gibs, core, cavity, slides, heaters)
Identify surface finishes for molds
Identify types of molding materials (e.g., glass, plastic, rubber, die cast, pressware)
Describe the fitting and assembly process

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,C |

**Competency:** **Describe the process of extrusion/pultrusion**

**Competency Builders:**

Explain extrusion method/pultrusion
Identify machines and dies used in extrusion
Identify applications for extrusion
Identify auxiliary equipment needed

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,C |

**Competency:** **Describe compression molding**

**Competency Builders:**

Explain compression molding method
Identify machines and molds used in compression molding
Identify applications for compression
Identify auxiliary equipment needed

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,C |

**Competency:** **Describe injection molding**

**Competency Builders:**
Explain injection molding method
Identify machines and molds used in injection molding
Identify applications for injection molding
Identify auxiliary equipment needed

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,S |

**Competency:** **Describe blow molding**

**Competency Builders:**

Explain blow molding method
Identify machines and molds used in blow molding
Identify applications for blow molding
Identify auxiliary equipment needed

408

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,S |

**Competency:** **Describe thermoforming**

**Competency Builders:**

Explain thermoforming method
Identify machines and molds used in thermoforming
Identify applications for thermoforming
Identify auxiliary equipment needed

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,C |

**Competency:** **Describe rotational molding**

**Competency Builders:**

Explain rotational molding method
Identify machines and molds used in rotational molding
Identify applications for rotational molding
Identify auxiliary equipment needed

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | S,C |

**Competency:** **Describe calendering method**

**Competency Builders:**
Explain calendering method
Identify machines and molds used in calendering
Identify applications for calendering
Identify auxiliary equipment needed

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,S |

**Competency:** **Describe foam processes**

**Competency Builders:**
Explain foam processes method
Identify machines and materials used in foam processing
Identify applications for foam processes
Identify auxiliary equipment needed

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | C,S |

**Competency:** **Describe powder coating**

**Competency Builders:**

Explain powder coating method
Identify machines and materials used in powder coating
Identify applications for powder coating
Identify auxiliary equipment needed

## Unit: Material Joining Technology

**BIL:** Recommended

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | R | M,C |

**Competency:** **Perform basic soldering of electrical components**

**Competency Builders:**

Prepare surfaces to be soldered
Select appropriate solder
Select appropriate flux
Select appropriate soldering iron temperature
Select appropriate soldering iron tip shape
Select appropriate flux remover
Select appropriate surface sealant
Inspect solder joints under microscope
Identify good and bad solder joints
Measure solder joint resistance of good and bad joints

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Operate wave soldering machine**

**Competency Builders:**

Inspect surfaces to be soldered
Select appropriate solder
Select appropriate flux
Set all machine parameters (e.g., temperature, wave amplitude, transport velocity)
Inspect solder joints of completed printed circuit boards

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Solvent weld plastic joints**

**Competency Builders:**

Prepare surfaces to be joined
Select appropriate cleaners
Select appropriate adhesive
Make and inspect joints
Review and adhere to appropriate codes

**BIL:** Recommended

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | R | |

**Competency:** **Thermal weld plastic joints**

**Competency Builders:**
Prepare surfaces to be joined
Select appropriate cleaners
Select appropriate heat gun temperature
Select appropriate inert gas and flow rate
Select appropriate plastic rod if required
Make and inspect joints

# Unit: Welding Basics

**BIL:** Essential

| | | | |
|---|---|---|---|
| **EDU:** | 12 | AD | AC |
| | I | P | M,S |

**Competency:** **Perform basic gas welding, brazing, and cutting**

**Competency Builders:**
Follow safety guidelines
Differentiate welding and brazing
Identify gas welding and cutting equipment and accessories
Use personal protective equipment required for welding and cutting
Explain capillary attraction as it applies to metal
Demonstrate proper lighting, adjusting, and shutting down of gas torch
Layout mild steel
Cut mild steel
Braze mild steel
Solder non-ferrous metals
Apply basic metallurgy technology

**BIL:** Essential

| **EDU:** | 12 | AD | AC |
|---|---|---|---|
| | I | P | |

**Competency:** **Perform basic arc welding/cutting (e.g., stick)**

**Competency Builders:**
Identify arc welding equipment and accessories
Explain process of resistance welding
Explain process of projection welding
Explain process of flash-butt welding
Explain process of laser welding
Explain process of friction welding
Explain process of spot welding
Explain process of shielded metal-arc welding (SMAW)
Explain process of gas metal-arc welding (GMAW)
Explain process of gas tungsten-arc welding (GTAW)
Explain process of plasma-arc cutting
Explain process of carbon arc gouging and cutting
Explain process of welding plastics
Explain welding rod alloys
Read welding rods
Explain mild steel welding rod
Explain low hydrogen welding electrode
Explain rationale for preheating and post-heating metal
Explain (GMAW) welding in flat, horizontal, vertical positions
Explain (GTAW) welding on mild steel, stainless steel, and aluminum
Explain process of build up and hard facing
Troubleshoot fusion of materials
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum
Apply basic metallurgy technology